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Final Report of

NORTHERN CALIFORNIA

TRANSIT DEMONSTRATION PROJECT

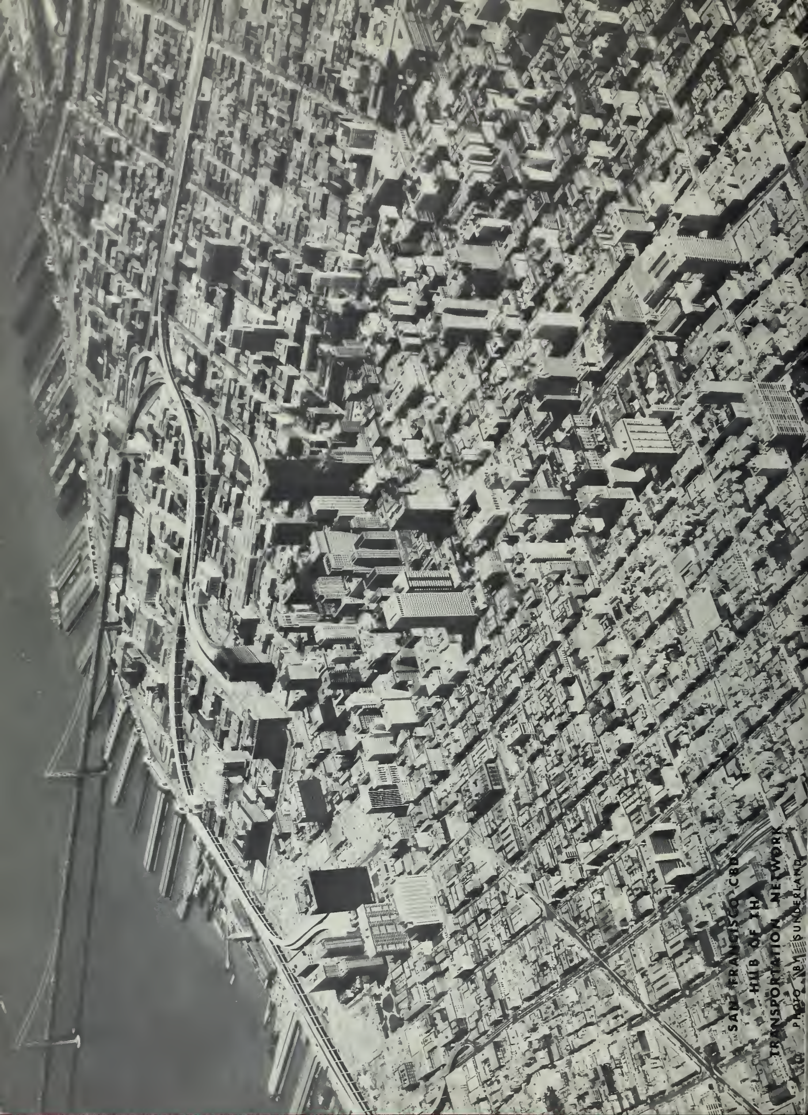
COORDINATED TRANSIT FOR THE SAN FRANCISCO BAY AREA

— NOW TO 1975

Cal. MTD-5 and Cal MTD-6

December 1967

PREPARED BY SIMPSON & CURTIN — TRANSPORTATION
ENGINEERS — PHILADELPHIA & SAN FRANCISCO



SAN FRANCISCO CBD:
HUB OF THE
TRANSPORTATION NETWORK
PHOTO BY SUNDERLAND

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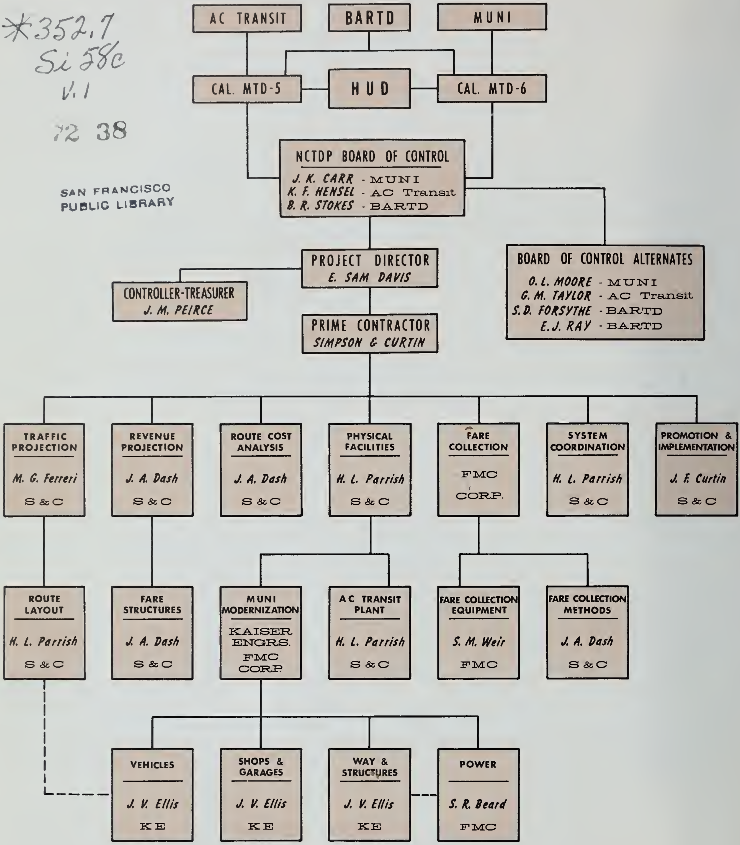

FOREWORD

WHEN THE VOTERS OF ALAMEDA, Contra Costa and San Francisco Counties endorsed the $800 million BARTD bond issue in late 1962, they sparked a renaissance in rapid transit development. This 75-mile regional network will be the first rapid transit service in the west and promises to be a strong magnet in drawing auto commuter patronage away from streets and highways. To be successful, however, the attraction must provide more than a 70-mile-per-hour ride across San Francisco Bay; the seconds saved in line travel will be dissipated in minutes lost at stations, if the rapid transit service is not effectively coordinated with surface transit operations on both sides of the Bay.

Two sets of coordination problems—unique and somewhat conflicting—were created by the voters' go-ahead signal to build BARTD. One deals with the interfaces between the new rapid transit service and the established surface transit networks. From the outset, transit managers recognized a variety of tasks in how the services should be correlated to develop the optimum in areawide transit facilities. Foremost in this respect is the operation of feeder service to and from rapid transit. This involves further questions on joint fares, collection and handling of fares, transferring of passengers, sharing of revenues, well-timed meets between trains and buses, etc.

The other problem area deals with the impact of BARTD on existing transit systems. These operations—AC Transit, Muni and Greyhound—are well-established services, each with a comprehensive network of routes catering to regular riding habits. Substantial parts of their systems will be affected by the BARTD facilities. It is necessary, therefore, to determine first the impact of rapid transit on these surface operations, and secondly, the alterations needed to operate and maintain the balance of these systems for the remainder of the service area beyond the influence of rapid transit.

The initial steps in defining these several problems were taken late in 1963 when an informal joint committee was organized by the operating staffs of AC Transit and BARTD. Soon after, operating officials of San Francisco Municipal Railway joined the sessions when it became evident that their problems were as intimately connected as those of the other two transit agencies.

By the middle of 1964, the conferees had developed their thoughts on coordinating the three services into a general work program. And it became evident that the problems were of sufficient magnitude to require outside assistance—financial, engineering and otherwise—to accomplish desired results. As a result, a request was made for federal assistance from the Housing and Home Finance Agency, now the U.S. Department of Housing and Urban Development (HUD).

The implementation of this coordination objective then comprised several steps in close succession:

- A 'joint exercise of powers' agreement was developed under which the three agencies were combined into a task force for carrying out this particular coordination study;
- A detailed work program comprising seven basic sections was prepared:
  - I—Transit Travel Characteristics
  - II—Vehicles and Maintenance Facilities
  - III—Fare Collection

IV—Operating Revenues and Expenses
V—Fare Systems
VI—Impact Studies
VII—Transit Promotion

together with administrative procedures for the study (Appendix A).

- A budget was prepared for the seven-part study program and its administration (Appendix B).

To satisfy administrative restrictions upon the local agencies and federal fiscal requirements, two applications were submitted: one by AC Transit District with BARTD as a participant; the other by the City and County of San Francisco with BARTD as a participant. While this technical split was maintained during the study for administrative and budgetary controls, the project was conducted as a single venture throughout under the name:

NORTHERN CALIFORNIA
TRANSIT DEMONSTRATION PROJECT

Direction and overall supervision of the study were maintained by a three-man Board of Control:

James K. Carr, General Manager of San Francisco Public Utilities Commission
Kenneth F. Hensel, General Manager of Alameda-Contra Costa Transit District
B. R. Stokes, General Manager of Bay Area Rapid Transit District

One full-time officer—Project Director—was appointed by the Board of Control; his responsibility included administration of the project, monitoring and review of the consultant's activities, handling of relations with other state and federal agencies and general supervision. A Controller-Treasurer also was designated for fiscal matters which were handled within BARTD's accounting and auditing services to keep the project in line with other ventures subject to regulations of the Department of Housing and Urban Development.

The professional activities in the project were handled by consultants. Proposals were received from a dozen professional engineering organizations and firms experienced in the transit industry. These were reviewed carefully by the Board of Control, which finally selected the firm of Simpson & Curtin of Philadelphia to serve as primary consultant. Two other agencies—Kaiser Engineers of Oakland and FMC Corporation of Santa Clara—were chosen as subcontractors on special phases of the program.

The administrative organization and functional division of the work program are illustrated in the accompanying figure.

While the primary mission in the project has been to develop the means of coordinating these three transit systems into a unified system, particular attention was directed also at new methods or schemes which might have application elsewhere than in this particular coordination effort. Several technical items of interest in service coordination were developed; these are described in the appropriate sections of the study report. From an administrative standpoint, it is worthwhile to call attention here to three items which contributed to the effective conduct of the study.

1. Primary emphasis was placed upon electronic data processing, resulting in the development and handling of a large data bank of information on major phases of the project at considerable savings in time and labor. The use of computers in place of professional and clerical labor was a major element in keeping the project cost within budget limitations, notwithstanding a two-year span of active inflation.
2. A series of documented Technical Memoranda for each work item was prepared by Simpson & Curtin, reflecting developments as the work program progressed. These memoranda were more than progress reports; they provided background of existing operations, indicated alternatives and set forth the principal guidelines in evaluating alternatives under each of the several tasks of the project. Through this medium, the Board of Control was able to maintain close check on progress. More than that, each of the operating agencies was currently informed on the trend of study developments and afforded continuing opportunities to comment on the course of the project.

   This feedback was a significant directional force to the consultants. Twenty-four Technical Memoranda were distributed, ranging from seven on the comprehensive task of traffic and route analysis down to one for transit promotion (Appendix C).

3. Study findings and preliminary results were reviewed periodically with staff members of the three agencies, with an explicit understanding that such review was exploratory and involved no commitment of that particular operating agency. By this arrangement, the consultants were able to bring about a better understanding and agreement on details, even where policy matters might differ.

This final report sets forth the steps necessary for full coordination of rapid and surface transit in the Bay Area. It includes the premises and methods used in drawing these three divergent types of operation from their traditional patterns into a coordinated network determined by community goals, operating economy and patrons' preferences.

A noteworthy feature of the plan is its completely regional character, overriding the boundaries of incorporated cities and towns as well as the three counties comprising the service area. This is in keeping with both the desire and spirit of these local municipalities and agencies to look beyond their traditional interests and restrictive political boundaries in a sincere effort to provide for a regional transportation need on a comprehensive basis.

This report sets forth the recommendations of the consultants together with alternatives considered. These recommendations do not have the approval of the Board of Control, although the report has the Board's sanction for its release, nor does the report reflect the attitude of any of the agencies individually, either approving or disapproving the recommendations herein. It should be recognized that the primary function of this project has been to provide guidelines to the agencies in working out their ultimate arrangements for coordination of their transit operations.

It is intended that the distribution of this report will be extensive, not only to those interested in the project within the area served, but also to planning and operating agencies interested in transit development generally. And it is hoped that the techniques and systems set forth in this study, as well as the various proposals and recommendations made by the consultants, will be useful in bringing other communities to an effective solution of their transit coordination problems.

Close cooperation was maintained throughout the study with city, county and state public agencies involved in transportation problems in the Bay Area, as well as other interested individuals, universities and companies throughout the nation. Data were exchanged with the Bay Area Transportation Study Commission, California Division of Bay Toll Crossings, West Bay Rapid Transit Authority, Marin County Transportation Study and the San Francisco Downtown Parking and Traffic Study.

The assistance provided by the California Division of Highways, the various planning agencies of the communities and counties involved, which are too numerous to mention individually and, of course, the staffs of the participating agencies is specifically acknowledged.

E. Sam Davis
Project Director

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REPORT IN BRIEF

INTRODUCTION . . . Chapter 1

THE RUGGED TOPOGRAPHY which makes San Francisco a picturesque city is also the reason underlying its reliance upon transit. Within the city proper, steep grades on the numerous hills are a deterrent to auto travel. Suburban communities are separated from the central city by San Francisco Bay and by mountains, limiting access to its two world-famed bridges and a few land gateways to the south. These topographical barriers and the city's residential density (31 persons per acre) combine to make San Francisco highly dependent upon public transportation; per capita transit use is second only to New York and substantially greater than Chicago and Philadelphia, although both latter cities have vast rapid transit networks.

Study Area—The travel habits of over two million people are involved in the Northern California Transit Demonstration Project study area, blanketing the three transit systems under consideration:

- The City of San Francisco, all of which is served by its municipal railway (Muni);
- Portions of Alameda and Contra Costa Counties served directly by AC Transit;
- Daly City and other communities in northern San Mateo County served by either Muni or Greyhound commuter routes;
- Areas in Alameda and Contra Costa Counties within range of AC Transit or Greyhound commuter routes.

Service territory of the Bay Area Rapid Transit District (BARTD) is conterminous with this study area.

Study area population is projected to reach 2¾ million persons by 1975. The bulk of this will occur in the sparsely developed sections—southern Alameda County, eastern Contra Costa County and portions of northern San Mateo County. In anticipation of this, study boundaries were extended beyond service limits of existing transit systems.

San Francisco is a compact, fully developed city with a residential population of 755,000 and daytime population in excess of one million. Downtown San Francisco is the center of commercial, retail and civic activities—not only the hub of the entire Bay Area but the principal financial, shopping and commercial center for the prosperous West Coast.

The East Bay area divides into two major geographical sections separated by Berkeley Hills, (1) a coastal plain of over a dozen incorporated cities and towns strung together in a 40-mile north-south chain three to eight miles wide, and (2) a broad valley east of the hills which includes Lafayette, Walnut Creek, Pleasant Hill, Concord and other communities.

Surface Transit Systems—Muni is a city-owned transit operation with 61 surface routes providing extensive coverage throughout San Francisco. It carries 409,000 adult passengers daily, more than half of whom board or alight in the CBD, and utilizes over 900 vehicles in four types of service—streetcars, electric trolley coaches, motor buses and cable cars.

PRINCIPAL TRANSIT CARRIER serving East Bay communities is Alameda-Contra Costa Transit District (AC Transit). This operation accommodates a million people in a string of communities—Oakland, Berkeley, Alameda, etc.—adjoining San Francisco Bay from San Pablo to Hayward. Local service is provided, as well as arterial routes between them. AC Transit also operates a substantial transbay service over the Bay Bridge to a downtown San Francisco terminal. 240 motor coaches are used in transbay service, accommodating 36,500 passengers daily. In the East Bay, AC Transit uses another 330 motor vehicles furnishing 49,000 miles of service for 90,000 adult riders daily.

Regional Rapid Transit—Construction is under way on the Bay Area's new 75-mile rail rapid transit system. BARTD is notable on several counts: it is the first brand new transit venture in this auto-oriented country in half a century; 61% of local taxpayers voted for a $792 million bond obligation to launch the system; its conceptual development features high-speed travel and passenger amenities in a forthright appeal to lure commuters out of automobiles. Operation of BARTD is scheduled to begin on the East Bay in 1969, with the balance of the system completed by 1971. BARTD will be underground for most of its length in San Francisco, across the Bay and in Berkeley; some sections will operate on aerial structure, with remaining portions on restricted right-of-way at grade.

In San Francisco, the BARTD line will serve the CBD along its principal axis under Market Street, continue through the Mission district to the southwestern part, terminating in Daly City. On the East Bay side, three lines are being built outward from downtown Oakland—one north to Richmond, another east to Concord and the third line south to Fremont.

The system is being developed for maximum rider appeal, with high-speed operation, automatic train control, attractive trains and stations, etc. BARTD stations will have average spacing of two miles to accommodate speeds of 40-50 m.p.h.; speed in the transbay leg will run up to 80 m.p.h.

Systems Analysis—A new technology in transportation planning has emerged in recent years through development of an interdisciplinary systems approach, similar to methods of operations research used in space and other advanced sciences. The socio-economic factors influencing transportation are correlated into mathematical models, then tested by simulation procedures. In areawide transportation studies, this systems approach is proving effective in coping with the growing complexity of forecasting consequences of alternative policies, thus furnishing effective planning insight to decision-makers.

Not only is there a growing understanding of future transportation alternatives in terms of probabilities, but this systems approach also makes it evident that substantial influence may be exerted over these probabilities. In other words, the transportation future is no longer vague and unforeseeable, but inevitable; instead, there are a variety of alternative futures, with related probabilities, which can be reasonably forecast—and to some degree, manipulated.

The basic approach is that transportation embraces a comprehensive system of interrelated activities, involving adaptation of transportation facilities, spatial organization of land and human activities, demographic and social characteristics as well as consumer choices in determining transportation modes. Some of these are grouped into transit system characteristics—route locations, operating speed, headways and fares; others are rider characteristics such as trip origin and destination, travel purpose and auto ownership, while the third groups of factors governing transportation are land use characteristics—residential density, employment, commercial activity, etc.

The task has been to develop reliable measures of these variables for the Bay Area, preliminary to drawing correlations between them and segregating those having a measurable effect on transit usage. With existing relationships established and validated, mathematical models are designed to simulate growth characteristics of the Bay Area, reflecting the future travel distribution. Alternative layouts of rapid and surface transit systems are then developed and tested by superimposing the matrix of travel desires on each route to furnish a 'loaded' network.

THE TWO MODELS developed for plan evaluation—combination fare model and cost allocation model—are among the more significant contributions of NCTDP to systems analysis in the transit planning process. By these techniques, various layouts for Muni and AC Transit have been coordinated first between traffic and routes, then between costs and fares, and this iterative process repeated until the raison d'etre of the project has been accomplished—optimum transit service in the Bay Area by 1975.

BAY AREA TRAVEL MARKET

PRESENT TRANSIT TRAVEL . . . Chapter 2

A composite picture of transit travel in the Bay Area was developed by quizzing one-quarter million transit riders for details of their riding habits. This O/D survey revealed significant findings on the 535,000 adult riders in the Bay Area on the average 1965 weekday—41,600 of whom traveled transbay, 93,600 in the East Bay and 399,500 in San Francisco and peninsula communities.

Transbay Service—Buses are only 3% of transbay traffic, yet they transport 45% of transbay workers and shoppers to downtown San Francisco in peak periods.

The four principal East Bay cities—Oakland, Berkeley, Alameda and Richmond—generate over 20,000 transit rides daily to and from the San Francisco CBD. Oakland is the largest single production area, originating 9,800 transbay journeys. Altogether, there are 27,040 trips daily on AC Transit and Greyhound vehicles from East Bay communities to downtown San Francisco—the flow pattern of which corresponds to the BARTD alignment.

San Francisco CBD attracts more East Bay riders than the Oakland CBD—27,040 compared to 23,200. However, over three times as many riders shop in downtown Oakland as cross the Bay on shopping trips.

Over 20% of transbay riders use automobiles to get to their boarding stops. On Muni and AC Transit local lines, only 5% and 6% of riders, respectively, either drive or are driven. It is significant that this additional portion of transbay riders—15% more than local transit users—use automobiles to reach the buses, yet choose not to drive all the way to San Francisco. It suggests that, to the extent a coordinated BARTD-Muni-AC Transit system will improve the speed, comfort and convenience of transit riding, more automobile drivers can be influenced to switch to transit.

East Bay Transit Travel—Downtown Oakland attracts nearly 25% of AC Transit's local travel from East Bay communities on the average weekday. Six out of 10 riders to the Oakland CBD start within Oakland itself. Another one out of 10 begins from Berkeley, while one more travels from Alameda. These communities have frequent and direct service so that more than 80% of riders bound for Oakland CBD complete their journeys on one vehicle without having to transfer. Automobile use as a means of reaching the local bus is more pronounced percentagewise in communities farthest from the Oakland CBD—Castro Valley, Hayward, Richmond and San Leandro.

Transit Travel in San Francisco is predominantly CBD-oriented; 209,000 Muni passengers enter and leave downtown San Francisco daily.

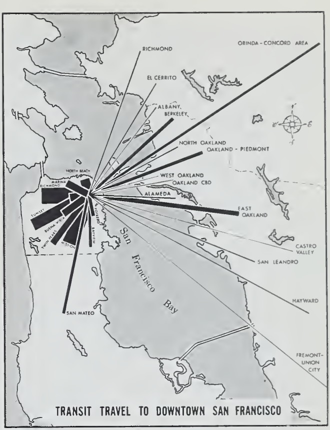
Walking is the dominant travel means to and from Muni service, reflecting widespread and convenient area coverage. Fewer than one out of three riders transfers to a second vehicle to complete his journey.

WITHIN SAN FRANCISCO, travel from the Richmond district accounts for more trips (33,378) to downtown than any other residential district. Other major corridors to downtown are Sunset (24,482) and Mission (28,746) districts. The latter will be served well by BARTD.

Home-to-work travel accounts for the majority of transit rides in virtually all classes of service. Eight out of 10 transbay riders are making work-related trips; the remaining 20% are distributed among shopping, personal business, social-recreational and other activities. On Muni streetcars and buses, seven out of 10 riders are traveling between home and work; about 8% are shoppers, while another 11% are on personal business trips. Few riders use transit for social-recreational travel; the major exceptions are cable car lines, particularly Mason and Hyde Street routes, where 25%-30% of patrons are tourists.

Auto Ownership and Availability—More than two-thirds of AC Transit riders are 'captive,' i.e., they do not have an automobile available for trips by transit. 38% do not own a car and another 30% do not have one available for transit journeys.

Among transbay riders, approximately 50% own and have available at least one automobile for the journey but they use AC Transit buses instead, demonstrating the ability of fast and attractive transit service to draw commuters even when they have an option of auto use.



TRANSIT TRAVEL TO DOWNTOWN SAN FRANCISCO

PRESENT HIGHWAY TRAVEL . . . Chapter 3

Auto travel is by far the dominant means of transportation in the Bay Area and will continue in that role for the foreseeable future. In assessing transit's future market, it was necessary to define total travel activity not only in terms of transit but also the use and supply of highway facilities. Planning data from the California Division of Highways, adapted to the 474 NCTDP study zones, were used for these trip generation and distribution computer programs.

The busiest single facility in the Bay Area is the San Francisco-Oakland Bay Bridge. This double-decked facility carries 130,000 vehicles daily. The Golden Gate Bridge, connecting San Francisco with Marin County, carries 70,000 vehicles a day. Major routes across the southern limit of San Francisco accommodate 172,000 vehicles entering and leaving the city daily.

Over 70% of downtown San Francisco travel is by auto and taxi. Transit access is gaining slowly, although it represents only 27% of the total downtown movement. But the efficiency of transit is revealed in the evening peak period—4:30 to 5:30 P.M.; streetcars and buses carry almost half the persons moving yet represent only 2% of vehicles on downtown streets.

The San Francisco CBD is the area of maximum interest for potential travel divertible to future transit improvements. Transbay vehicular trips to downtown San Francisco amount to 33,570 daily—36% of the total transbay volume terminating in the NCTDP study area. Similarly, major desire lines of auto travel within San Francisco converge upon its downtown area, accounting for 353,180 vehicular trips daily.

Travel time ratios, i.e., travel time via transit in relation to highways, were determined for every pair of zones in the 474-zone study area to assess transit's comparative attractiveness. Trips to the employment hub (Montgomery and California Streets) indicate travel time ratios from 0.5 to 3.5; in other words, there are some zones where transit is twice as fast as the automobile and others where auto travel is 3½ times as fast as transit.

For travel to the CBD, transit now holds its own or is faster than autos from 15% of the 172 zones in San Francisco. With a five-minute travel time improvement, the number of zones where transit would have the time advantage over autos would be doubled, bringing 30% of San Francisco zones into the range of transit travel time advantage. This analysis is particularly valuable in pointing out the locations where improvements in speed and quality of transit service could have competitive impact.

EXISTING TRANSIT SERVICE . . . Chapter 4

Muni operates four types of vehicles—cable cars, streetcars, trolley coaches and motor buses—in three functional categories of service: arterial routes serving the CBD; crosstown lines and feeder routes. System revenue is just under 75¢ per mile. The weakness in placing reliance upon this unit value is revealed in the cable car operation; its fare receipts aggregate $2.74 per mile, yet the cable car lines are the greatest losers in the system.

Muni's level of service, patronage and productivity have remained unusually constant in recent years. There have been no fare increases, no new equipment, no mileage increases or decreases and virtually no change in patronage levels. Nine measures of regular route operations show less than 2% variation between 1960 and 1965. Meanwhile, over the same period, surface transit systems throughout the country had an aggregate passenger decline of 15.2%, mileage drop of 7.9% and decrease in passengers per mile of 8.1%.

AC Transit is an all-bus operation composed of two major services—transbay and East Bay. The 12 transbay lines account for nearly one-third of system mileage and slightly over one-fifth of passenger traffic. Due to longer rides and higher fares, however, transbay routes produce nearly 40% of system revenue.

Appreciable increases have occurred in patronage and amount of service on AC Transit since the Transit District took over operations of the Key System in late 1960. Transbay mileage rose 13% between 1961 and 1965, while East Bay service increased 12%. As result, revenue passengers carried and passenger revenue have gained substantially. The revenue rise was 18% on the 12 transbay lines, and about half that on East Bay service. On East Bay arterial and crosstown lines, the gain in passengers and revenue was less than the mileage increase, with the result that unit revenue dropped.

Muni Operating and Plant Facilities—For the most part, present Muni facilities are outmoded, inadequate and overdue for replacement. Rolling stock consists of 1,028 revenue vehicles and 96 service cars and trucks. It includes 75 White gasoline buses, 449 Mack diesels, 360 trolley coaches of various manufacture, 105 PCC streetcars (most of which are secondhand) and 39 cable cars dating from 1893.

Muni's maintenance facilities comprise six operating divisions and three overhaul shops. Vehicle needs and maintenance facilities are summarized as follows:

- All facilities are exceptionally crowded, causing double shifts, interference with housekeeping and cleaning of vehicles and unnecessary transfer of maintenance and storage between divisions. Lack of yard space has caused numerous instances of body damage, further straining the limited body shop facilities.
- High maintenance on the buses' power, trains and brake linings due to severe grades imposes a double load on maintenance facilities.
- Space requirements for transit equipment are critical; any cutbacks for BARTD or city facilities at Muni's expense will only jeapordize further the system's low performance capability.
- Outmoded vehicles—White buses, PCC cars and trolley coaches—require Muni to provide maintenance through cannibalization, or manufacturing parts through expensive castings and/or machining.

AC Transit Operating and Plant Facilities—By contrast, AC Transit has a comparatively modern fleet and plant facilities. Rolling stock consists of 685 diesel coaches, 400 of which have been acquired since 1960. 112 buses are air-conditioned.

AC Transit vehicles are maintained at three operating divisions—Richmond, Emeryville and East Oakland. These operating and maintenance depots have been modified in recent years in step with overall growth of the Transit District. They are well equipped with modern maintenance and service facilities and entirely adequate for the AC Transit fleet.

PRESENT FARE SYSTEMS . . . Chapter 5

Fares are probably the most sensitive aspect of a transit service, representing a balance between political considerations and need for operating revenues. In the Bay Area, this sensitivity is evident in both Muni and AC Transit; despite continual operating deficits, both systems have held to obviously low fares for several years.

Muni has one of the lowest and simplest transit fare plans in the nation—a citywide 15¢ fare for adults, 5¢ for children and students, free transfers, no tokens and no zones. This fare has been in effect since 1952.

AC Transit has zone fares, but the first zone is so large as to approach an areawide flat fare plan. More than 80% of East Bay journeys are one-zone rides. The basic adult fare is 25¢ with a 20¢ token rate. Zone increments for the four additional zones are 5¢ and 10¢ each. Transbay fare between the central East Bay zone and downtown San Francisco is 50¢ cash or 45¢ on a commute ticket.

Greyhound provides extensive suburban commuter service in the Bay Area. Compared with Muni and AC Transit, its fares are higher and more extensively zoned. The minimum Greyhound fare is 30¢; cash fares run up to $1.15 between San Francisco and more distant points in the NCTDP study area. Greyhound offers monthly commutation tickets between San Francisco and East Bay communities, and 20-ride commute books between San Francisco and peninsula communities.

Combination Fares—There are no joint fare arrangements between Muni and AC Transit. O-D studies reveal a substantial interchange of passengers between the two, particularly at the San Francisco Transbay Terminal. Combination fares for multi-vehicle journeys between systems will become particularly significant when BARTD is superimposed on them.

Among the 22 largest metropolitan areas in the country, only Philadelphia and Washington have combination fare arrangements between suburban and local transit systems to any significant degree. In both cities, joint fare tickets are sold by drivers manually; neither the sale nor collection is automated.

PRESENT TRANSIT COSTS . . . Chapter 6

A pioneer effort has been made in this study to develop an appropriate measure for projection of future costs among Bay Area transit systems by design of a cost allocation model reflecting amount of service, operating speed, trip length and other service parameters in individual route performance. As a first step, the trend of major cost elements on the Muni and AC Transit systems was analyzed for recent years to determine normalized cost levels and rate of change. Thereafter, the allocation model was developed to serve as a basis for apportionment of expenses to individual routes and to evaluate unit cost variations induced by major route changes, as contemplated in subsequent network proposals.

Aggregate operating costs for Muni system in 1965 amounted to \$1.057 per mile for all types of service. Substantial variation existed among the several classes; bus operations required 93.1¢ compared with \$1.045 per mile for trolley coach, \$1.15 for streetcar and \$4.966 for cable car operations. Two adverse factors in the cable car cost picture are two-man operation and average speed of 4.6 m.p.h.

AC Transit's system unit cost was 64¢ per mile in 1965. Despite an increasing mileage base for spreading fixed costs, unit expenses have been rising at an average rate of nearly 4% for several years.

Cost Allocation—Five elements of primary value have been identified in allocating expense items: vehicle hours, vehicle miles, peak vehicle needs, miles of line and passenger revenue. Wages is the largest single item of expense; since operating and maintenance employees are paid on an hourly basis, vehicle hours of service provide the best measure of this item. Certain other costs, such as power or fuel, tires, equipment maintenance and items involving wear, are related directly to miles of operation on each route. On the other hand, storage facilities for vehicles is a function of number of vehicles required to operate a line, rather than miles or hours of service. Similarly, expenses in servicing vehicles—fueling, cleaning, washing, etc.—are more nearly a function of number of vehicles than any other variable. Way and structures expenses for track and power service are related to length of line. And, finally, accident costs and claims expense are related generally to line revenues throughout the industry.

Cost formulas for four classes of Muni service were derived:

Streetcar: $C = 6.328H + 0.31691M + 7{,}412V + 2{,}478L + 0.11792R$

Cable Car: $C = 11.058H + 1.608M + 11{,}859V + 4{,}969L + 0.19624R$

Trolley Coach: $C = 6.108H + 0.16978M + 7{,}000V + 404L + 0.09462R$

Bus: $C = 6.359H + 0.15755M + 7{,}420V + 155L + 0.11456R$

San Francisco Convention & Visitors Bureau

Where: C = Average annual cost of operation
H = Vehicle hours
M = Vehicle miles
V = Morning or evening peak vehicles
L = Length of line in miles
R = Route revenue in dollars

A similar analysis of AC Transit operating experience normalized and updated to 1967 cost levels yielded the following formula:

Bus: $C = 6.209H + 0.11089M + 5{,}788V + 0.03865R$

These formulas were used for analyzing current services by Muni and AC Transit, particularly in determining the margin between operating revenues and expenses for arterial routes, feeder lines, transbay routes, East Bay express and local lines, etc.

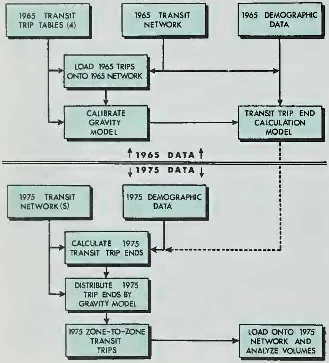
OPERATING RESULTS IN 1965 . . . Chapter 7

Both existing local transit systems in the Bay Area had substantial deficits in 1965. Muni collected $19,904,816 in operating revenues and spent $27,966,377 without depreciation, leaving an operating loss of $8,061,561. Muni has been regularly running deficits in a range of $5 to $10 million annually since 1960.

In operating ratio terms, operating costs were above revenues by 33% on streetcars, 78% on cable cars, 22% on trolley coaches and 53% on bus routes.

Operating results for AC Transit in 1965 were somewhat more favorable, but they also totaled to a system deficit of $1,463,421. Operating revenue aggregated $13,363,691, while cost of service amounted to $14,827,112. Transbay service was a profitable operation; the excess of revenues over operating costs on the 12 transbay lines was $670,000—15% of transbay revenues. On East Bay arterial routes, there was a deficiency of $940,000 (14%), while crosstown lines failed to meet costs by $245,000 (72%). Feeder operations of AC Transit lost well over $1 million, with costs running approximately 214% of operating revenues.

TRANSIT TRAVEL ESTIMATING PROCESS


1965 TRANSIT TRIP TABLES (4)
1965 TRANSIT NETWORK
1965 DEMOGRAPHIC DATA
LOAD 1965 TRIPS ONTO 1965 NETWORK
CALIBRATE GRAVITY MODEL
TRANSIT TRIP END CALCULATION MODEL
1965 DATA
1975 DATA
1975 TRANSIT NETWORK (S)
1975 DEMOGRAPHIC DATA
CALCULATE 1975 TRANSIT TRIP ENDS
DISTRIBUTE 1975 TRIP ENDS BY GRAVITY MODEL
1975 ZONE-TO-ZONE TRANSIT TRIPS
LOAD ONTO 1975 NETWORK AND ANALYZE VOLUMES

Like its West Bay counterpart, AC Transit has been managed as a deficit operation, with partial reliance on tax proceeds, since its conversion to a publicly owned system in 1960. Supplementary receipts from local taxation have increased steadily from $445,000 in 1961 to $2,345,000 in 1966.

Subject to various restrictions and limitations, Muni and AC Transit have access to tax proceeds, not only for capital funds, but for operating and maintenance expenses as well. The same is true for BARTD to a limited degree. For the most part, communities in the Bay Area have been ahead of the rest of the country in recognizing that supplementary transit revenues from general taxes and other sources are a sound community investment in encouraging greater patronage of public transportation. Recent developments in New York City, Boston and Pennsylvania, as well as enactments by Congress, indicate a growing awareness of the value of good transit service, reasonably priced and supported where necessary by revenue from non-transit sources.

TRAVEL RELATIONSHIPS . . . Chapter 8

The transit industry has long recognized and quantified the impact of factors affecting riding, particularly as related to transit service itself. Formulas for measuring the effect of fare increases or service reductions upon transit patronage are in regular use. In addition, there are variables known to affect transit use, outside the purview of management. These relate to characteristics of transit patrons and land use.

Rider characteristics include the diversity of socioeconomic factors pertaining to the needs and aspirations of people in moving from place to place. One reflection of the desire for higher living standards is the rise in auto usage over the past two decades. The third group of factors affecting transit riding involves land use characteristics; each land use activity—central city commercial, residential, industrial, etc.—generates or attracts travel flow of a particular nature and magnitude.

Fifty-two variables were tested for their possible influence upon transit tripmaking. Certain of these were discarded due to difficulty in expressing accurate measurement or inability to forecast them with confidence; others were dropped for low correlation with transit use. Stepwise multiple correlation through use of high-speed electronic computers was the principal technique in drawing correlations among remaining variables. For each class of transit traffic, a mathematical expression was developed among the significant variables—a transit use model—which became the basic tool for evaluating results of altering the framework within which the present transportation network functions.

Transit Use Model—The estimating technique developed in this study differs from modal split models prepared by other areawide transportation studies in its basic concept. The modal split methodology generally develops the total travel market by calibrating trip generation of total person trips, then splitting this market into transit and auto segments. This assumes a constant pool of trips generated by land use and person characteristics, which remains the same regardless of what type of transit system is planned—only the modal split changes. Under the approach developed in this study, each segment of the travel market is independently derived from characteristics of tripmakers, land use and system factors. By this method, the total pool of trips varies under different systems, as well as the split between transit and auto usage. Greater statistical validity from an in-depth transit O-D survey enabled NCTDP to develop estimating equations by which transit trips were derived directly rather than as a percentage of total travel.

Twelve trip estimating equations were developed to express the relationships among variables influencing three basic categories of travel—home-based-work, home-based-non-work, and non-home-based. These three trip purpose categories involve separate equations for trip production and trip attraction, separated between San Francisco zones and remainder of the Bay Area. The latter stratification was necessary by reason of significant differences in transit use characteristics within the city proper compared with travel within the East Bay and other sections on the peninsula. These 12 equations were made up of the following independent variables and their combinations as applied to each of the 474 NCTDP zones.

1. Population
2. Employment
3. Automobiles owned
4. Gross population density
5. Median family income
6. Weekday miles of transit service
7. Service density measured by transit miles per acre
8. Transit travel time from each zone to downtown Oakland and downtown San Francisco
9. Auto travel time from each zone to downtown Oakland and downtown San Francisco
10. Composite peak hour headways in minutes
11. Composite off-peak hour headways in minutes
12. Employment density in jobs per acre
13. Number of transit seats on weekday schedule

After the models for trip production and attraction were developed, another model was devised for distributing trips between zones. This phase of the estimating process was adapted from the gravity model, used widely in areawide transportation studies.

Accuracy checks were made throughout the estimation process as a test of the system's ability to reproduce present day travel as it occurs 'on the street.' Comparisons between Muni maximum load points around the San Francisco CBD and estimated volumes from the 1965 simulation network showed the network link data to be 0.04% more than the Muni cordon count. With this degree of estimating accuracy, the models were deemed sufficiently fine-tuned for route planning.

POPULATION AND ECONOMIC GROWTH . . . Chapter 9

The vigor with which the Bay Area continues to grow provides the substance upon which future estimates of transit use are founded—anticipated people and jobs in 1975. With nearly three million people currently, the San Francisco-Oakland metropolitan area is the nation's seventh largest population center. More significantly, it is one of the fastest growing among the top metropolitan areas in the country.

NCTDP study area population is estimated to increase 20% by 1975. Most of this will occur in the sparse areas of the East Bay; San Francisco will increase only 4% in the decade 1965-1975.

Projection of San Francisco population to reach 785,000 by 1975 is based upon an evaluation of prior projections, the city's Community Renewal Program and extrapolation of the 1960-65 growth rate.

San Francisco Employment Projections—The State Employment Department reveals a steady growth in jobs within San Francisco over the past 20 years—averaging 3,670 jobs annually since 1955. Based on this and projected modifications by the State Employment Department, a total city employment of 513,000 is estimated for 1975.

Downtown San Francisco is experiencing a construction boom in office buildings—more than one million square feet added in 1965 alone, bringing the city's downtown office space to nearly 20 million square feet. The CBD accommodated 282,000 jobs in 1965—58% of San Francisco's total employment. Another 19,000 jobs will be available by 1975, bringing CBD job attractions to over 300,000. This will represent nearly two-thirds of the total job gain throughout San Francisco in the 10-year span from 1965 to 1975.

From a transportation standpoint, it is important to recognize that while San Francisco's population growth rate is estimated at 4% over this decade, the rate of increase for downtown employment will be nearly twice that—reflecting not only the employment attraction beyond city limits but the increasing demand for improved regional transit facilities.

Alameda County—Communities in Alameda County within the study area will grow 19%, or nearly 200,000 persons, in the 10-year period 1965-1975. Three-quarters of this gain will occur in the southern portion—in the less intensely developed communities such as Fremont, Newark, Union City, etc.

Oakland is the largest city in Alameda County and also the most fully developed. A projected increase of 14,400 residents, less than 4%, is expected by 1975; most of this is expected in the eastern hilly portion and the southern section of the city.

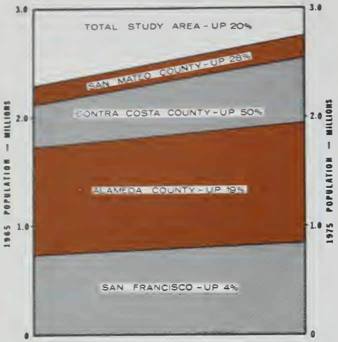
Berkeley is another fully developed community in the East Bay, particularly around the University of California campus, where densities range up to 30 persons per acre. It will grow only slightly in the next decade 'by its own choice.'

Employment in the study area section of Alameda County totaled 365,280 jobs in 1965. Differential rates of employment growth follow the pattern of population increases to the extent that the upper portion of the county currently accounts for 85% of total jobs.

Jobs are projected to increase by 68,500 in the 10-year span to 1975. Almost one-half of this will occur in the undeveloped southern portion. These projections were developed with heavy reliance on data supplied by the Alameda County Planning Department for five community labor markets defined by the California Department of Employment.

Contra Costa County—The part of Contra Costa County within the NCTDP study area is split by the Berkeley Hills into two sub-areas for analysis purposes. The Richmond-San Pablo area had a population of 168,072 in 1965; this is projected to increase to 210,000 by 1975. Throughout this area, population densities range between 10 and 20 persons per acre, except for a few zones of heavier density in Richmond and San Pablo proper.

With respect to employment, relatively heavy increases—in excess of 30%—are forecast for parts of



NCTDP STUDY AREA
POPULATION GROWTH
1965 – 1975

Richmond. Job gains in excess of 10% are projected for San Pablo, El Cerrito and the remainder of Richmond.

The 1965 population of eastern Contra Costa County was 215,800. This is projected to reach 363,600 by 1975—a rise of 68%. Except for a portion of Concord, population density throughout this area is less than 10 persons per acre. Even with a projected rise of more than two-thirds it will remain comparatively sparse in 1975.

Eastern Contra Costa County is destined to continue primarily residential. Jobs will rise as communities develop in size, but at less than one-half the rate of population growth. An overall increase in employment of 30% is projected for the 1965-1975 period, matching the 68% rise in population.

FUTURE TRAVEL MARKET

TRANSIT TRAVEL IN 1975 . . . Chapter 10

Prospective transit travel involves two primary considerations: (1) the anticipated volume of passengers using surface and rapid transit service, and (2) the layout of routes to accommodate this anticipated riding. Under the systems approach utilized in this study, coordinated transit network and trip generation models permitted simultaneous testing of a complete set of route configurations with each system analysis. In a typical test run, all 120 (or more) surface transit routes, as well as the rapid transit lines, were laid out to match anticipated travel desires. This produced a test network which then was coded for machine simulation and 'loaded' with the future origin-destination travel matrix to reflect the resulting use of each transit route in that system.

To limit the number of alternatives, a testing program was devised for bracketing the ultimate solution by first testing extreme possibilities, then refining between them. In the case of AC Transit, two basic network philosophies were first evaluated. In one test, no changes were made in AC Transit transbay and East Bay express routes, except that the BARTD alignment was superimposed on them. This was tried to assess the impact of BARTD and point out the routes which could not withstand competitive BARTD service. The other extreme for AC Transit operations was analyzed in the second run; all transbay and East Bay express lines were eliminated, while arterial, crosstown and feeder lines were rerouted to stations to facilitate transfer to BARTD.

Similar bracketing was used in the San Francisco layouts by first testing a rapid transit 'feeder' plan, then analyzing a 'through route' plan, stressing the advantages of one-vehicle service. While neither of the extreme networks was wholly acceptable, these alternatives quickly pointed up the significant aspects of each. Succeeding proposals then were tested for each system by linking the favorable alternatives developed from prior test runs. Five complete transit networks were developed for the AC Transit system and four such arrangements for Muni before the recommended plans were finally determined. When the computers indicated that further network refinements would not produce higher transit volumes or faster travel, the optimum future transit system in the Bay Area was accomplished.

1975 Transit Market—The Bay Area transit market is estimated to increase from 534,731 adult trips daily in 1965 to a new pool of 673,109 adult trips in 1975, before fare adjustments. If school children are added, the projected market for transit at the three-quarter century mark will be 812,000.

Principal factors underlying this 26% transit gain expected over 10 years are the addition of BARTD and a supplementary three-part Muni rapid transit system in San Francisco. Population growth is also a factor, but its effect is primarily to offset the prevailing diversion of transit riders to automobiles. In the 1955-1965 decade, transit riding declined in the Bay Area notwithstanding a 20% population increase.

Transbay travel will attract the largest share of increased transit usage; an 81% increase from 41,600 to 75,244 adult trips daily in 1975 is projected. All of this gain, as well as most present transit riders crossing the Bay, will be on BARTD. AC Transit system is expected to continue in transbay service, but at a much reduced level. Compared with a daily level of 33,540 AC Transit transbay patrons in 1965, the traffic estimation process foresees only 3,640 bus riders over the Bay Bridge daily in 1975—a drop of nearly 90%. In addition, all Greyhound patronage from Contra Costa County to San Francisco—more than 8,000 riders daily—will be diverted to BARTD.

For trips wholly within the East Bay, the impact of BARTD is not expected to be as severe on AC Transit. Total East Bay adult journeys are projected to rise from 93,627 to 110,450 daily in 1975, an 18% gain. BARTD will divide this market with AC Transit on an approximately equal basis. While it will lose a significant share of arterial travel, AC Transit will more than offset this by picking up a high proportion of feeder trips to BARTD stations for both East Bay and transbay journeys. The net result will be an overall gain of 12% in passengers handled by AC Transit, but for trips of considerably shorter length.

BAY AREA AVERAGE WEEKDAY ADULT TRANSIT TRIPS
1965—1975
(Prior to Adjustment for Fare Differentials)

	1965	1975	% Change
TRANSBAY			
AC Transit	33,541	3,640	
Greyhound	8,054	—	
BARTD	—	71,604	
Total	41,595	75,244	+80.9%
EAST BAY			
AC Transit	91,719	53,845	
Greyhound	1,908	—	
BARTD	—	56,605	
Total	93,627	110,450	+18.0%
SAN FRANCISCO—WEST BAY			
Muni Surface	382,188	154,428	
Muni Rapid	—	198,949	
BARTD	—	113,080	
Greyhound	17,321	20,958	
Total	399,509	487,415	+22.0%
TOTAL	543,731	673,109	+25.9%

The impact of BARTD on the Muni system is not expected to be as great. San Francisco adult journeys are forecast to rise from 399,509 to 487,415 daily in 1975, a 22% overall gain. BARTD will share this market with Muni, but the latter is expected to retain about three-fourths of it. Even with this lesser proportion, however, San Francisco will be the prime market for BARTD riding due to its greater aggregate volume. Many surface route volumes will drop significantly, but Muni will offset this decline with new rapid transit riding and also by gaining feeder trips to BARTD stations.

BARTD Riding in 1975—The dominant transit attraction throughout the Bay Area in 1975 will be BARTD. To a considerable degree, optimizing transit use in the area means optimizing use of BARTD; this is the principle followed in developing the coordinated route plan. The result is that nearly one out of three transit trips in 1975 will use BARTD for at least part of the journey.

BARTD has potential 1975 ADT of over 253,000 riders—29% in transbay travel, 24% locally in East Bay and the remaining 47% within San Francisco. Maximum accumulation on BARTD will occur on Market Street in downtown San Francisco between Civic Center and Powell Street Stations.

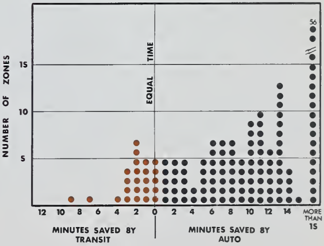
Montgomery Street will be the most heavily used BARTD station, with over 116,000 passengers boarding and alighting daily.

A substantial share of BARTD traffic will come from present auto users, under the NCTDP trip forecasting procedure. 32.3% of BARTD travelers in the East Bay will be diverted from automobiles; in transbay service, BARTD will draw 30.3% of its patronage from motorists crossing the Bay Bridge. These estimates represent a higher proportion of transit diversion from auto travel than any rapid transit facility has been able to attract heretofore. Yonge Street Subway in Toronto drew 12.9% of its patronage from former auto users, while the two newer rapid transit systems in Chicago—Congress Street Rapid and Skokie Swift—were able to divert 12.5% and 17.5% respectively. With high operating speeds and distinctive passenger amenities, BARTD is expected to be twice as effective as these other rapid transit developments in luring motorists out of automobiles.

The most significant impact of BARTD will be upon San Francisco-Oakland Bay Bridge. 21,000 transbay auto-person trips will be diverted daily to BARTD in 1975. In terms of peak hour usage, this amounts to 3,200 vehicles in the peak hour/direction—more than two lanes of auto travel. Coupled with the fact that 80% of transbay buses will also be diverted, net effect of BARTD will be to add three peak hour/direction lanes to present bridge capacity.

The foregoing calculation does not take into account the fact that AC Transit now provides four lanes of transit patronage in both the morning and evening peaks. BARTD will assimilate nearly 90% of this volume and, in addition, divert more than two lanes of auto travel to subway movement. Its overall effect, therefore, will be the equivalent of seven transbay lanes in the peak hour/peak direction. In terms of equivalent capacity, BARTD will be equal to another Bay Bridge in delivering East Bay citizens to downtown San Francisco each morning.

Recommended AC Transit Network—Under Plan E—the recommended route layout for AC Transit—30 of the 65 present routes are modified to feed BARTD, two are changed for reasons unrelated to BARTD, 21 remain unchanged, 12 are eliminated, and one new route is added. Six transbay routes are proposed for continued operation, but on a much reduced basis. With these six lines reduced by more than 50% in volume and elimination of the remaining 10 transbay lines, AC Transit travel will be cut to 5% of the transbay market. Two East Bay express routes are retained in the recommended plan; the remaining five are eliminated.


COMPARATIVE TRAVEL TIME TO DOWNTOWN SAN FRANCISCO

172 SAN FRANCISCO ZONES

Transit now has a time advantage in only 15% of San Francisco zones. A 10-minute improvement in transit time would triple the potential market.

The transbay decline on AC Transit lines will be more than overcome by gain in feeder traffic to BARTD. Total adult riding on AC Transit will increase by 1975 to over 43 million passengers annually from the 1965 level of 35,700,000—a gain of 21%. Express services will decline materially, but the arterial routes altered to serve BARTD stations, as well as crosstown and feeder routes, are expected to rise by 36% and 229% respectively.

Under the recommended plan, more than half of AC Transit patronage in 1975 will be BARTD-related. 65% of crosstown and feeder route patronage will be to and from BARTD stations, as well as 56% of riders on East Bay arterial and express routes.

Recommended Muni Network—The Muni route system will be substantially altered by BARTD, although not to the same degree as AC Transit. Several other missions, in addition to coordination with BARTD, were sought in the Muni rerouting:

- Define other corridors for rapid transit development;
- Test over 50 requests for route extensions and other service changes submitted by various organizations and individuals;
- Develop other route changes unrelated to BARTD for improving the Muni system.

Four complete transit networks were developed and tested before arriving at a recommended plan of optimum transit usage for San Francisco. In each, some grade-separated service has been included in addition to BARTD. Present transit volumes in Richmond, Sunset and Twin Peaks corridors show a warranty for grade-separated service. As a result, rapid transit in a variety of forms—conventional rail operation, express bus on separate rights-of-way, high-speed streetcars in subway-surface operation, etc.—was evaluated.

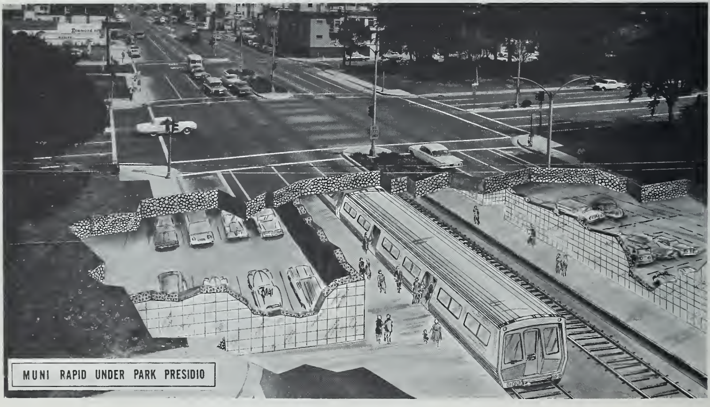
The recommended network (Plan D) provides for a four-prong system of rapid transit lines from the southern and western sections of the city to downtown San Francisco, supplemented by bus rapid service on present and committed freeways in the Bayview corridor. In addition, it includes 54 surface routes, with several new crosstown lines, others rerouted for connection to rapid transit, and some retained to accommodate intermediate travel.

Adult riding on Muni surface routes under the recommended plan is expected to reach 147 million annual users from the 1965 level of 126 million riders—a gain of 17%. 60% of this surface patronage in 1975 will be 'rapid related;' 29% to BARTD and 31% on connecting surface legs to other Muni rapid transit lines.

Further gains in transit use in San Francisco are expected from improved service by the proposed network of Muni Rapid lines. Passenger projections anticipate almost 200,000 riders daily, divided among Richmond Rapid (55%), Sunset Rapid (13%), Twin Peaks Rapid (10%) and Market Street (22%). Montgomery Street Station will be the heaviest on the system for all three Muni grade-separated routes, in addition to BARTD. From these several analyses, it is evident that the transportation hub of the entire Bay Area is centered at Market and Montgomery Streets.

This rail rapid transit network would serve nearly four-fifths of the city's total population. Approximately one-fifth will be within easy walking distance and another three-fifths will have short feeder bus access to rapid transit service connecting directly with the commercial/shopping/civic centers of downtown San Francisco.

Time savings on Muni Rapid routes would vary from eight to 18 minutes each way. The rapid transit running time would be under 14 minutes from the outer ends of all four lines to downtown San Francisco. This recommended plan, therefore, would bring 95% of



MUNI RAPID UNDER PARK PRESIDIO

the city's population within Mayor Shelley's goal of making San Francisco a 20-minute city, i.e., 20 minutes travel time from any outlying point to the downtown area.

Feeder Lines in New Service Area—Additional feeder service to BARTD has been considered in three peripheral sections of the NCTDP study area beyond the service territories of AC Transit and Muni—eastern Contra Costa County, southern Alameda County and northern San Mateo County.

The BARTD Concord line will extend 16 miles beyond present AC Transit territory in eastern Contra Costa County. A network of 11 bus routes has been designed to feed BARTD and provide local service. This recommended feeder network will afford service to population clusters within six to seven miles of the BARTD line. Beyond that, the added mileage expense and lack of patronage makes cost of such service prohibitive.

Southern Alameda County includes two BARTD stations—Union City and Fremont—which extend six miles below present AC Transit territory. A network of seven feeder routes has been designed for this portion of the BARTD service territory.

Northern San Mateo County will be served by the BARTD Daly City Station. This area now has eight bus routes, three operated by Greyhound Lines and five local routes by Northgate Transit Company. These lines, coordinated with BARTD, should fill the need for feeder bus service pending development of a comprehensive transit plan for San Mateo County by the West Bay Rapid Transit Authority.

FUTURE NEEDS—VEHICLES, PLANT & MANPOWER . . . Chapter 11

Eight out of 10 transit patrons in 1975 will either use a different bus route, or rapid transit train which they have not yet seen, to make the same journey as in 1965. This transformation will require more than just route configurations: substantial modification of vehicles, plant and manpower for both AC Transit and Muni will be involved.

Vehicular Requirements—AC Transit is an all-bus operation and will remain so for the foreseeable future. The redistribution of traffic with BARTD in operation will reduce its peak vehicle requirements by 35%. Allowing for school, special service and spares, a fleet of 500 coaches is projected for 1975.

Muni's vehicle needs are more difficult to assess, due not only to rapid transit and other route changes, but also its present equipment deficiencies and prospects for conversion. Two-thirds of trolley coaches will be eliminated, as result of curtailment of five such routes and conversion of four others to bus operation.

Peak vehicle needs for the three rapid transit lines will be 104 high-platform transit cars. Modern rapid transit vehicles with advanced styling and other traveling conveniences are recommended, comparable to proposed BARTD vehicles. After careful consideration, these were chosen over PCC-type and articulated streetcars, due to their superiority in greater capacity, proven experience and compatibility with structures of the existing Twin Peaks Tunnel and new Market Street Subway.

Five additional cable cars are needed; pains should be taken to assure that these are as antiquated as the rapid transit cars are modern, in keeping with the present cable car fleet.

Muni Modernization Program—Further improvements in Muni plant and facilities to achieve the recommended system for 1975 will involve major rehabilitation of existing shops and garages, and addition of new way and structures. A program of Muni modernization has been developed for (a) vehicles, (b) way and structures, (c) shops and garages, (d) cable car system, (e) power system, and (f) special facilities. Several alternatives for staging these capital additions, involving replacement of virtually every vehicle and facility in the present system, have been considered.

Foremost elements of the comprehensive transit plant will be the three additional rapid transit way and structures:

RICHMOND RAPID—A double-track rail tunnel with 12 stations under Post Street and Geary Boulevard, from Market and Montgomery Streets to 45th Avenue —a distance of 5.85 miles. The structure would also include provision for future BARTD connection to Marin County.

TWIN PEAKS RAPID—BARTD will construct the subway under Market Street with connections to the Twin Peaks Tunnel and extend that to St. Francis Circle. Extension of the line is recommended past the Stonestown Shopping Center to San Francisco State College and Parkmerced.

SUNSET CORRIDOR would be up-graded in two stages. Initially, the present Judah streetcar tunnel would be renovated, paved and lighted for express bus service. Thereafter, a new rail tunnel would be built between Market Street and 19th Avenue—a distance of 3.0 miles. This structure would be similar to the Twin Peaks and Richmond Subways in cross-section, with provision for further extension into the Sunset district at a future date.

Extensive rebuilding of Muni shop and garage facilities is required. Six new or rebuilt divisions are proposed at a capital cost of $17.3 million:

- Kirkland Division—New garage and office facilities;
- Ocean Division—New two-level storage and service facilities;
- Potrero Division—Convert existing trolley coach structure to motor coach service operation;
- Presidio Division—Improve existing trolley coach service accommodations and modernize Muni general offices;
- Automotive Overhaul Shop—New two-story structure for motor overhaul, body and paint shops, etc.;
- Rail Service Facility—An underground installation with storage yard, servicing, repair and overhaul facilities and shop offices, adjacent to Twin Peaks Subway for rapid transit maintenance.

Modification of the existing power system—including new substations and power distribution facilities—will be needed to accommodate the rapid transit and remaining trolley coach operation. And certain transit furniture items—speedwalks, minibuses, traffic priorities, bus shelters—are recommended also for passenger convenience and improvement of operating efficiency.

This comprehensive program of Muni transit improvements is estimated to aggregate $310 million to $395 million, depending upon which of several alternatives is finally chosen. A first-phase program, aggregating $96.5 million, was the subject of public referendum in November, 1966. The bond issue received approval of 58% of the voters, indicating a favorable disposition towards the program but short of the two-thirds endorsement required under San Francisco charter.

Manpower Requirements—AC Transit's manpower requirements in 1975 will be slightly reduced. The total work force is estimated to decline from 1,416 in 1965 to 1,371 in 1975, with the reduction taking place in maintenance and salaried forces primarily.

On the other hand, a 33% increase in the Muni work force is projected for 1975. Operators, maintenance force and office workers will increase 18-20%, in addition to which 400 rapid transit employees will be needed. Matching this, Muni service—including rapid transit—is projected to increase 45%. Thus, under the coordinated system, a higher volume of service will be provided by a lesser increase in manpower and vehicles, yielding greater productivity as well as a more attractive transit system.

FARES AND PASSENGER REVENUE IN 1975 . . . Chapter 12

Various fare proposals were considered from the standpoints of public acceptance and policy considerations, then tested for their influence upon traffic generation and revenue production. With several choices on each system, as well as inter-system alternatives, the initial problem was to narrow the range, then determine the effectiveness of fare components upon passengers and revenue. Following this, the cost side of the equation was introduced and the iterative process of revenue and cost projections repeated until reasonable balance was achieved.

Four fare plans were considered for BARTD, including the 'Composite Report' proposal. While all four have the same minimum and maximum fare—25¢ and $1.00, respectively—the differences in block rates for trips of intermediate length were substantial. Two alternatives were studied for AC Transit, present fares and a straight 25¢ rate, both predicated on retention of existing zone patterns. Machine tests for Muni fares included three alternatives—the present 15¢ fare, a 20¢ and 25¢ adult rate for surface rides, with a 25¢ Muni Rapid fare.

In addition to these, combination fares for feeder trips via Muni or AC Transit surface vehicles to BARTD were considered at 10¢ and 12½¢ per one-way feeder ride.

In deriving passenger revenue under alternative fare plans, careful consideration was given to sub-modal split—the distribution of riders between rapid transit and surface lines—and the effect of fare differential upon it. A family of fare/time differential diversion curves, stratified by fare differences between rapid and surface transit, was developed for internal redistribution of traffic between rapid and surface routes, without affecting the aggregate volume of transit riding.

The next step was to determine the impact of fare increase upon transit volumes under the several fare plans. Universally, fare increases in the range herein considered have produced revenue gains for the transit systems involved. But it is also a universal phenomenon that some passenger riding is lost due to each fare increase, no matter how nominal.

In the light of past experience in San Francisco and elsewhere, a shrinkage ratio of 0.20 was estimated for the Bay Area with fare increases up to 25¢ or less. This would produce a reduction of 6.7% in Muni surface patronage under a 20¢ fare and 13.3% patronage loss under a 25¢ fare. A lower shrinkage ratio is anticipated on BARTD and Muni Rapid because of the superior quality of service and passenger amenities on rapid transit compared to existing transit forms in the Bay Area. Particularly when rapid transit service is being introduced, higher fares are expected to have an inverse effect upon riding, but less than the passenger loss would be on existing service.

Machine Run V was designed to test the productivity of the lowest level of fares meriting consideration under prevailing financial requirements. It included the BARTD fares outlined in the Composite Report (Plan B-1), a 20¢ surface and 25¢ rapid transit fare for Muni (Plan M-2) and the present 25¢ cash and 20¢ token fare for AC Transit (Plan A-1), with 10¢ feeder fares from either Muni or AC Transit to BARTD. Results of this analysis indicated that the three systems can be expected to accommodate 331 million revenue passengers in 1975, with operating revenue of almost $62.5 million as follows:

System	Fare Plan	Revenue Passengers	Passenger & Advertising Revenue
BARTD	B-1	57,647,315	$20,965,748
Muni Rapid	M-2	42,808,241	10,498,212
Muni Surface	M-2	169,082,425	21,317,970
Muni Total	M-2	211,890,666	$31,816,182
AC Transit	A-1	61,233,949	$ 9,661,666
TOTAL		330,771,930	$62,443,596

Machine Run VI was designed to maximize revenue potential within the range of fares prevailing among other Bay Area commutation carriers—Greyhound and Southern Pacific Railroad—and the industry generally. It consisted of a 25¢ to $1.00 fare scale for BARTD with 50¢ minimum for transbay trips (Plan B-4), 25¢ Muni fare on surface and subway lines (Plan M-3) and 25¢ basic fare on AC Transit (Plan A-2), with feeder fare to BARTD of 25¢ for the round trip on either Muni or AC Transit. In other words, the local one-zone surface fare would be 25¢ on both sides of the Bay, with half fare (12½¢ for each one-way surface leg) for feeder trips to and from BARTD. This machine run produced an expectancy of 325.5 million patrons and passenger & advertising revenue of $71.6 million, subdivided among the three systems as follows:

System	Fare Plan	Revenue Passengers	Passenger & Advertising Revenue
BARTD	B-4	56,552,832	$25,723,433
Muni Rapid	M-3	44,634,798	11,052,428
Muni Surface	M-3	163,862,047	24,253,232
Muni Total	M-3	208,496,845	$35,305,660
AC Transit	A-2	60,414,714	$10,607,791
TOTAL		325,464,391	$71,636,884

Serious consideration has been given to the elements involved in devising an equitable formula for sharing the joint fare discount among affected transit systems. The amount to which a surface system is entitled for carrying a joint fare rider could be developed in relation to the length of ride and fare charged for non-feeder trips on that particular local system. An alternate approach would relate the amount to be received by the local system for carrying the feeder line passengers to the average cost per passenger on the entire surface operation. Another fundamental approach would be to relate the average length of ride for feeder passengers on a particular local system to the length of ride on the rapid transit line to which feeder passengers are delivered.

There are other relevant factors—proportion of peak hour patronage, proposed level of fares, comparative length of feeder trips in relation to line haul—some of which are counterbalancing considerations. A wide variety of formulae can be devised provided there is agreement among the carriers on objectives. In this instance, the three transportation agencies will have to give more detailed study to policy on feeder service and its several complexities before a formula can be evolved. To a considerable degree, the final arrangement will depend upon how much feeder surface operation to BARTD is required and how much is realized in fare box revenue in the aggregate from that service.

A series of six discount proposals were analyzed for joint fare reduction, ranging from 5¢ to 12½¢ on surface feeders, in relation to revenue yield to surface and rapid transit systems.

Promotional Fares—A variety of promotional fares was also considered to augment those prevailing on AC Transit and Muni. Most significant among these is a reduced rate for multiple-trip ticket buyers. Eleven rides for the price of 10 is proposed on cash fares above 50¢. It is estimated that this discount would be used by 55% of patrons whose cash fare is at the 55¢-60¢ level, with higher proportions of discount sales for longer journeys up to 85% usage in the 90¢-$1.00 fare bracket. Off-peak promotional fares are also recommended for BARTD.

Station Parking Charges—Moderate fees for parking at BARTD stations are also proposed as a revenue supplement and also to prevent usurpation of space by others. Another consideration supporting a parking charge is the need for added revenue to offset feeder bus subsidies. Feeder routes to outlying stations will be at sufficient competitive disadvantage with autos in speed differences, without an added handicap of free parking. A 25¢ charge is recommended for all-day parking at BARTD stations.

An alternative would be to vary parking charges among BARTD stations according to supply and demand. Where available space exceeds demand, a substantial number of free stalls could be made available. At other locations, where the demand exceeds supply, a 25¢ charge would be made for most spaces and a preferential rate of 35¢ to 50¢ for parking stalls nearest to the station. This arrangement would maximize the revenue yield from the parking facility, while at the same time inducing some patrons to drive to alternate stations where excess space is available.

OPERATING RESULTS IN 1975 . . . Chapter 13

To evaluate the proposed fare structures, singly and in combination, it was necessary to determine their sufficiency in meeting projected operating expenses. This was accomplished by determining the amount of service required in each operation, then developing the cost of that service.

Future service levels were based from present quantity standards for each class of service. For example, if a route is now serviced at 300 vehicle-miles per 1,000 revenue passengers carried, and no substantial change in route function is made, future annual mileage was forecast at the same level of service. Modifications were made where bus arterial routes will be converted to rapid transit feeder or to crosstown lines. After determining annual miles to be operated on each route, vehicle hours were derived through use of speeds computed for each route in the network coding procedure.

A modification of the cost allocation models previously developed was devised for predicting future route operating costs. Sensitivity tests showed only minor deviation between three-variable and four-variable equations for cost allocation, less than the range of error inherent in the forecasting process. As a result, three-variable formulas were devised for forecasting costs of each class of future surface operation based upon vehicle miles, vehicle hours and passenger revenue.

Future cost/revenue relationships were developed initially for both surface systems, then extended to BARTD and Muni Rapid, to arrive at projected operating results for each system in 1975.

Muni surface revenues are projected at 73.0¢ per mile, with unit costs estimated at $1.18. Therefore, the surface lines' excess of cost over revenue in 1975 is anticipated at 45¢ per mile. This compares with a deficit of 31¢ per mile on the Muni system in fiscal 1965 and a loss of 59¢ per mile on Muni feeder lines. A major factor contributing to this operating loss is the high proportion of prospective traffic in low-fare feeder service. Approximately 60% of adult riders on Muni surface in 1975 will be making reduced-rate feeder trips to Muni Rapid or BARTD under the recommended plan.

Similarly, 57% of adult passengers on AC Transit lines in 1975 are expected to be riding buses to and from BARTD. Hence, AC Transit will receive a full fare from only 43% of adult patrons. Revenue per mile is projected at 45.2¢ in relation to unit operating costs of 80.8¢. Therefore, the AC Transit operation is expected to lose 35.6¢ per mile in 1975, prior to adjustment for discount sharing with BARTD and allowance for children and student fares. In 1965, feeder routes of AC Transit lost 36.6¢ per mile. Prospective results of operation for the entire system in 1975—when it will be essentially a feeder operation to BARTD—are anticipated to be substantially similar.

Rapid Transit Operating Costs—Future service levels on BARTD and the Muni Rapid system were determined from estimated passenger volumes at maximum load points on each line. An analysis then was made of rapid transit operating costs among six systems in North America, from which the cost factors at Chicago, Philadelphia and Cleveland were segregated as representing the most appropriate gamut for estimating future costs on BARTD and Muni Rapid. Four

categories of direct operating expense were analyzed: conducting transportation, maintenance of rolling stock, maintenance of way and structures, and power costs. Then, general and administrative expenses were added to provide the appropriate overall units.

Operating costs on these three rapid transit systems totalled 72.53¢ per mile at 1965 cost levels. Updating this to 1967 and making provision for differences in wage levels and projected operating speeds, an estimated cost of 80¢ per car mile for the Muni Rapid system was derived, excluding depreciation, taxes and debt service.

Similar analyses of prevailing differences between the rapid transit gamut and BARTD produced an estimated cost of 58¢ per car mile for the latter operation. BARTD will have the advantage of automation to reduce manpower requirements. Furthermore, its operating speed will average over 40 m.p.h. compared to speeds in other systems of 20-25 m.p.h.

Pro Forma Operating Results—With a coordinated feeder network and recommended fare plan (B-4), BARTD is expected to generate revenue of $27,723,433 in 1975. Service on the BARTD system will aggregate 23,442,000 miles; at a unit cost of 58¢, operating expense is estimated at $13,596,360. After allowing for discount-sharing payments to Muni and AC Transit of $1,538,057, as developed under Plan F, the estimated net operating revenue remaining would be $10,589,016. This is the amount available for debt service on rolling stock, depreciation, reimbursement of construction costs and appropriate reserves.

The principal item to be supported out of net operating revenue of BARTD is the cost of rolling equipment. BARTD's financing plan is based on equipment purchases made with bonds secured by operating revenues of the system. At a prospective car cost of $68 million, debt service requirements for these revenue bonds have been projected at $6,613,000, assuming a coupon rate of 4¾% and 25-year amortization. Therefore, the net operating revenue projected would provide 160% coverage for debt service on these revenue bonds, with the excess available for repayment of transbay tube approach costs.

With its recommended fare plan M-3 and the coordinated surface and rapid transit network previously outlined, Muni is expected to have an operating deficit in 1975 of nearly $7 million, as shown below.

Muni Rapid is expected to be a profitable operation producing net income of more than $4¾ million in 1975. Offsetting this will be the loss on Muni surface lines exceeding $12-2/3 million, part of which is chargeable to the Muni Rapid, since it includes feeder operations at reduced fares.

The net result after allowance for discount sharing from BARTD is a prospective annual loss of $6,947,080 in 1975. Similar calculations for the 20¢ fare plan on Muni surface lines—Plan M-2—produced $3,600,000 less passenger revenue and $500,000 greater operating expense by reason of increased mileage, yielding a projected deficit of more than $11 million. In the light of this, and recommended fares on the other systems, it appears logical to charge a basic fare of 25¢ on all three Bay Area systems.

This projected deficit of $7 million is slightly under actual deficits on Muni in the past few years.

Similar projections were made for AC Transit's reduced operation in 1975 based upon its recommended Route Plan E, Fare Plan A-2 and Discount-sharing Plan F, coordinated with the cost allocation model previously described. 1975 projections indicate operating revenue of $11,973,411 and operating expenses of $17,055,659, leaving a deficit of slightly over $5 million. This would require more than twice the tax proceeds which AC Transit has received annually in 1965 and 1966.

Combining the three recommended networks, transit operations are expected to expand to a gross figure of $72,736,900 by 1975. Expenses of the three systems will exceed this slightly; sum of the three operating cost estimates aggregates $74,177,200. This will leave a net areawide transit deficit of $1,440,300, which is within the acceptance level of communities on both sides of the Bay in recent years.

Perhaps the most significant prospect is the projected increase in transit revenue for the Bay Area in the decade 1965 to 1975. Passenger and advertising revenue of the two existing systems aggregated $33,089,000 in fiscal 1965. This is expected to rise to $72,736,900 ten years later—a projected expansion of 120%. Part of this is due to fare increase and the rest to an overall capital investment of $1.5 billion to provide the most advanced areawide transit system in the world. If this should appear optimistic, the promise is implicit in the pulling power of rapid transit, rather than any liberality in forecasting assumptions.

FARE COLLECTION . . . Chapter 14

BARTD will carry 56.5 million passengers in 1975, each of whom will pass through an entrance and exit BARTD station—a total of 113 million turnstile passes. Nearly two-thirds of the access trips to and from BARTD—74.4 million rides annually—will be made on buses and trolley coaches. The need for a convenient and efficient collection system for joint system riders is evident therefore.

Fundamentally, the problem is to develop a collection method involving two diverse manually-collected systems—Muni's flat fare and AC Transit's zone fare—and a fully automated collection plan on BARTD for a fare structure based on varying station-to-station rates. Fares on the Muni and AC Transit systems are collected on a pay-enter basis. BARTD plans a fully automated system, based upon stored value or stored trip tickets which are magnetically encoded and inserted by passengers in entrance and exit turnstiles.

	Muni Rapid	Muni Surface Lines	Muni System
Passenger and Advertising Revenue	$11,052,428	$24,553,232	$35,605,660
Discount-Sharing Payment from BARTD	—	—	972,437
Total Revenue	$11,052,428	$24,553,232	$36,578,097
Operating Expenses	$ 6,292,400	$37,232,777	$43,525,177
Profit (Deficit)	$ 4,760,028	($12,679,545)	($ 6,947,080)

FMC Corporation made a detailed analysis of existing fare collection techniques in the United States and Europe and outlined six alternative systems for this particular adaptation. Most of these required one or more machines on surface vehicles compatible with the proposed vending machines and registering turnstiles at BARTD stations. Considerable attention was devoted to these FMC suggestions and to other arrangements for joint fare collection in sessions with operating managers; it became evident, however, that the alternatives to be finally considered would be governed by two facts of overriding importance:

(1) The automated BARTD system will prohibit manual or visual elements insofar as BARTD legs of joint trips are concerned.

(2) Muni and AC Transit have a pronounced preference for a method which will not require special equipment on surface vehicles.

On this restricted basis, three alternative schemes were prepared.

Collection Plan A—The first arrangement provides that passengers would pay their BARTD and surface feeder rides—in one transaction. A two-part ticket would be sold by the surface line operator—one stub for the feeder trip and the other a 25¢ ticket on BARTD. For a three-vehicle journey including BARTD, the passenger would pay the combination two-vehicle fare and secure a free surface transfer, retaining this for use in the second surface ride.

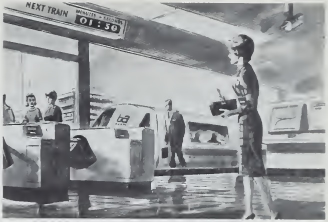
This proposal has several advantages: it provides for a discount on all one-way combination rides, is adjustable to various fare combinations and compatible with BARTD automated collection equipment. The disadvantages of this proposal arise in dealing with commutation tickets and other special fare groups such as students. Muni and AC Transit surface operators would have to carry stocks of separate joint tickets for adults, children, commuters, students, off-peak riders, etc. Similarly, money from the sale of joint tickets would have to be collected and accounted for by surface operators, requiring a system of inter-line accounting.

Under any joint fare ticket plan, the passenger would purchase a minimum fare ride on both the surface and BARTD services. It would be impossible, as a practical matter, to design a joint ticket covering the large number of fare possibilities on BARTD in surface vehicle transactions.

Collection Plan B—This scheme was designed to permit joint fares to be handled separately in each direction, granting a discount in one direction only. The patron would pay the regular fare on the surface trip to a BARTD station, as well as the prescribed BARTD fare. On his return, he would deposit 5¢ (or other amount below regular surface fare) in the vending machine, and receive a transfer entitling him to a surface ride. A passenger using two surface legs, before and after a BARTD journey, would be handled by a transfer plan.

The only special equipment involved would be transfer machines and validators within the paid area of BARTD stations. These would be coordinated with turnstiles to prevent passengers from buying more than one surface feeder transfer at the discount rate.

THE PRINCIPAL ADVANTAGE OF PLAN B is its simplicity. Everyone traveling to BARTD would pay the regular surface fare. Those leaving BARTD and wishing to use surface transportation would be accommodated by a simple procedure in daily use on many transit systems.



Nothing would be added to the duties of surface operators. The plan is extremely simple not only from the standpoint of collection but accounting as well. With the payment of the 5¢ deposit in the transfer-issuing machine to the surface system, both Muni and AC Transit would receive 30¢ for the round trip taken in conjunction with BARTD. Thus, if BARTD were to turn over the moneys collected from vending machines at its stations, the entire transaction would be closed at this point.

MAJOR DISADVANTAGE OF COLLECTION PLAN B is the imbalance caused by unequal fares for the same trip in two directions. The passenger who rides surface lines only to BARTD obtains no discount. On the other hand, the individual reaching BARTD by some other mode, then using the surface line when leaving BARTD on his return trip, pays only a 5¢ fare. This unbalanced fare to and from BARTD would have significant effects where alternate surface transit routes are available. Some combination rides would be diverted entirely to surface lines in the direction where no discount is provided. In the return direction, the same passenger would choose the joint ride involving BARTD, realizing both the time savings and the added discount.

Under normal conditions, 95-98% of BARTD-related patrons will be round-trip riders. This collection plan, however, is likely to distort this proportion.

Collection Plan C—This third fare collection plan is designed to function independently of the BARTD collection procedure. For a Muni-BARTD or AC-BARTD round trip, the patron would pay the regular surface fare and receive a BARTD exchange ticket, good for the return surface ride without added charge, after validation within the BARTD station. The procedure would work in reverse for a BARTD-Muni or BARTD-AC round trip; the passenger would obtain the exchange ticket within the BARTD paid area by depositing part or all of the surface fare, then use that for the outbound trip from BARTD while getting a transfer for the surface trip returning to that station. Similar adaptations would be made for Muni-BARTD-Muni or AC-BARTD-AC round trips.

Plan C is not as simple in operation as Plan B but it would be easily understood by passengers, no burden to operators and tight accountingwise. Plan C does not permit a one-way discount; this defect, however, would apply to only 2-5% of BARTD-related riders on Muni and AC Transit.

UNLESS THE THREE SYSTEMS INVOLVED decide that every joint passenger must be granted the opportunity for discount on a one-way basis, some variation of Plan C appears to be the most acceptable arrangement.

SUMMARY OF TRANSIT RECOMMENDATIONS FOR 1975

. . . Chapter 15

The recommended transit network for the Bay Area consists of:

- BARTD—A three-prong rapid transit layout in the East Bay converging to a transbay link running diagonally across San Francisco, with 33 stations—25 in the East Bay and eight on the San Francisco side.
- MUNI—A fan-shaped feeder-trunk layout of surface and rapid transit routes converging upon the CBD as a hub. In addition to BARTD Mission line, three rapid transit trunk lines are proposed—Richmond Rapid, Sunset Rapid and Twin Peaks Rapid. Seventeen existing Muni surface routes would be modified to feed Muni Rapid lines, 12 rerouted to become BARTD feeders, 13 other Muni routes would remain unchanged and 12 would be modified for service improvements unrelated to rapid transit.
- AC TRANSIT—A BARTD-oriented network of 48 basic routes including six transbay and two East Bay express lines, one special route to Treasure Island, 13 arterials, and 26 crosstown and feeder routes.

In addition, 18 new feeder routes are proposed, 11 in eastern Contra Costa County and seven in southern Alameda County, beyond service limits of existing AC Transit operations.

The numerous route changes should be geared to four stages of BARTD operation: (1) initial service between MacArthur Station in north Oakland and South Hayward; (2) transbay service from Concord to Daly City; (3) BARTD extension between Richmond and MacArthur Stations; and (4) operation from South Hayward to Fremont. Further, some Muni changes involving trolley coaches should be accelerated as part of the Market Street rehabilitation program.

PROJECTED FLEET REQUIREMENTS for Muni in 1975 aggregate 706 vehicles consisting of 115 rapid transit cars, 450 motor coaches, 110 trolley coaches and 31 cable cars. This will be a 28% reduction in present fleet, substituting vehicles of greater capacity, speed and utility. The AC Transit system is projected as an all-bus operation of 500 coaches in 1975.

SHOP AND GARAGE FACILITIES—Extensive rehabilitation of Muni maintenance facilities will include four new garage, service and office buildings at major division points. Five new power substations and power distribution facilities will also be needed.

AC Transit will require some capital expenditures for improved shop and garage facilities, particularly to replace the BARTD land-taking at its Richmond Division. For the most part, however, this system's plant facilities are adequate.

OTHER MUNI CAPITAL FACILITIES—Further plant improvements are needed for Muni modernization:

- Cable Car Routes—Improvements to way and structures and equipment including partial re-railing, alarms, signals and braking systems for increased safety and efficiency;
- Cable Car Barn—Restoration including a visitors' gallery, museum, and displays to enhance its historical value;
- Power System—Solid state rectifier equipment in Twin Peaks substation and new substations for rapid transit facilities;
- Radio-telemetry Control—Two-way radio system for communicating with rapid transit and surface vehicles;

- Park-ride—An underground garage at Park Presidio to intercept Marin motorists and switch them to Richmond Rapid;
- Minibus—Side-loading vehicles for short downtown routes;
- Speedwalks—Electric walkways for passenger distribution at Market Street Rapid stations;
- Traffic Priorities—Bus actuated traffic signals on arterial routes, no-parking restrictions, lengthened bus stops and other priorities for speeding transit service;
- Bus Shelters—Attractive shelters with telephone information hookup at heavy street-loading points.

Recommended Fare Structures—New fare proposals for each of the three Bay Area systems and for combinations among them are recommended as offering the optimum balance between revenue production to support operations and attractiveness in drawing passengers to the systems:

BARTD FARES—A range of station-to-station adult fares, between 25¢ and $1.00, according to the following formula:

First 4 miles	25¢
4 to 10 miles	25¢ + 4¢/mile
10 to 15 miles	50¢ + 3¢/mile
Over 15 miles	65¢ + 2¢/mile
Maximum Fare	$1.00
Transbay	Mileage + 4 miles with 50¢ minimum
Peninsula	25¢ within San Francisco 35¢ maximum
Multiple-ride Tickets	11 rides for the price of 10, applicable to cash fares above 50¢
Sunday-holiday Pass	75¢ for unlimited rides on Peninsula
Sunday-holiday Pass	$1.00 for unlimited rides on East Bay lines
Station Parking	25¢ all-day at BARTD stations

AC TRANSIT FARES—Recommended fares for the modified AC Transit system include the following:

Adult Single Zone Cash Fare	25¢
Multiple Zone Increments	Same as present
Transfers	Free
Transbay Fares	Same as present
Surface Feeder to BARTD	25¢/Round Trip
Students and Children	15¢
Sunday-holiday Pass	75¢ for unlimited rides in the East Bay area

MUNI FARES—It is proposed that the Muni base fare be brought to the level of the other two systems:

Adult Fare	25¢
Surface Transfers	Free
Adult Combination Surface-Muni Rapid Fare	30¢
Surface Feeder to BARTD	25¢/Round Trip
Students and Children	15¢
Sunday-holiday Pass	75¢ for unlimited rides over entire system

COMBINATION FARES—As indicated, feeder trips to BARTD are recommended at 25¢ for the round trip so that the combination fare would be the full BARTD amount plus 12½¢ for the feeder journey in each direction.

Projected Results of Operations in 1975—The recommended transit plan for the three Bay Area systems is projected to produce an overall gain of 67% in revenue passengers by 1975. This increase is overstated by reason of the greater proportion of two-system journeys and feeder-rapid transit trips being tallied separately. The expected gain after adjusting for these will be closer to 30%—still an impressive gain for this 10-year period.

Passenger revenue is expected to rise 120%—one of the fastest growth expectations among major industries or services in the Bay Area. This will be the product of two items—more transit traffic and higher fares.

Operating costs are projected to rise 75%, from $43 million to $74 million. Deficit operations will continue at Muni and AC Transit. It is noteworthy, however, that the three systems in combination are expected to be much closer to a break-even point in 1975 than the two existing operations, Muni and AC Transit, have been in recent years.

PROJECTED 1975 RESULTS OF OPERATIONS

Three Bay Area Transit Systems

	1965	1975	% Change
Revenue Passengers			
BARTD	—	56,552,832	—
Muni	141,724,908	208,496,845	+ 47.1%
AC Transit	52,905,464	60,414,714	+ 14.2
Total	194,630,372	325,464,391	+ 67.2%
Passenger & Advertising Revenues			
BARTD	—	$ 25,723,433	—
Muni	$ 19,820,932	35,605,660	+ 79.6%
AC Transit	13,268,079	11,407,791	— 14.0
Total	$ 33,089,011	$ 72,736,884	+119.8%
Cost of Operations			
BARTD	—	$ 13,596,360	—
Muni	$ 27,966,377	43,525,177	+ 55.6%
AC Transit	14,827,112	17,055,659	+ 15.0
Total	$ 42,793,489	$ 74,177,196	+ 73.3%
Net Revenues			
BARTD	—	$ 10,589,016	—
Muni	$ —7,991,711	—6,947,080	+ 13.1%
AC Transit	—1,463,421	—5,082,248	—247.3
Total	$ —9,455,132	$ —1,440,312	+ 84.8%

PROMOTION OF TRANSIT SERVICE . . . Chapter 16

Effective promotion of transportation services involves the strategy for integrating four major marketing elements of surface and rapid transit systems—traffic analysis, service standards, fare policy and communication. The latter includes conventional informational services, bulletins, press releases, etc. It should be evident that the substance of informational services is generated within the service and fare policies which transit management seeks to impress upon the travel market. Since these merchandising elements are interacting, they should be considered as an integrated group rather than as separate and remotely related policy determinations.

PREVAILING DIFFERENCES among Bay Area communities reflect a variation in thinking on the function of transit. Some advocates sponsor transit out of disenchantment with costly freeways which disrupt neighborhood amenities in established urban areas. Other urban planners see transit as a prospective control device for regulating the physical and social problems of slum and blighted areas. Suburban developers are more interested in the influence of rapid transit on outlying real estate values. Among these multi-purpose goals, the three public transportation agencies are being developed under varying restraints with little relation to one another and only incidental consideration of their collateral effects upon each other or upon future community development. A reasonable degree of working cooperation prevails. But there is need for a higher order of coordination; the need persists for an orderly and economical program of urban transportation development—a system analysis that will not only provide an accurate perspective of needs and solutions, but one which will promote public acceptance of improvement programs. The transportation objectives for the Bay Area may be consolidated to embrace these influences:

- Attraction of a major share of peak-hour traffic to and from the San Francisco and Oakland business districts to relieve rush-hour traffic congestion on Bay bridges and other congested arteries;
- Reduction of all-day parking demands in business areas to provide more space for shoppers and other optional auto travelers in high-density areas;
- Mobility of pedestrian circulation in the business, shopping and civic centers of San Francisco, as well as the high density core areas of other Bay Area cities;
- Promotion of population growth in suburban residential sections;
- Controlled development of land use activities—residential, commercial, industrial and recreational—in accordance with local community desires; and
- Renewal and redevelopment of blighted areas.

FIVE PRINCIPLES ARE OUTLINED as guidelines for planning and operating each transit system in keeping with the economic and social interests of Bay Area residents and long-range goals for community development.

(1) Regional considerations, unrestrained by city limits, should be the basis for transportation planning;
(2) Close coordination of schedules, fares and other service matters is paramount;
(3) Transit market analysis should include more thorough understanding of auto travel and the influence of trip schedules—toll bridges, parking facilities, traffic control devices, etc.;
(4) The interrelationship between transportation planning and land activity should be more thoroughly explored;
(5) 'Cost-effectiveness' analysis should be the governing basis for significant decisions on metropolitan transportation.

To coordinate properly transportation planning with land development, population growth and economic expansion in the metropolitan area, a continuing forum should be established to apply the foregoing principles. A compact is proposed among Muni, AC Transit and BARTD for a dual purpose:

- To provide a forum for review of transportation policies and practices which have some interaction with the other transit agencies;
- To administer the joint promotional efforts which will be handled more effectively on a coordinated basis. This compact would be a successor to NCTDP and carry forward its organization and study recommendations. It would program future transportation developments, establish priorities and review procedures, including a system for keeping track of progress toward interim goals. Further, the compact would determine a budget for promotional services to be accomplished jointly, the formulas for which would be a function of joint fare allocation. A portion of the joint fares is suggested for transit promotion as a convenient means of apportioning costs and one which will have reasonable assurance of program continuity.

A coordinating committee has been set up by the three agencies for implementing the recommendations in this transit demonstration program.

Joint Promotional Services—Joint handling of certain basic informational services appears desirable to insure coordinated trip information to passengers. The three systems may retrain personnel to coordinate passenger activities, the same as airlines handle joint bookings; or, they could be integrated for certain passenger-handling functions, while retaining their corporate individuality, similar to operating units of the Trailways Bus system. Items to be considered for joint administration include:

Computerized Informational Service
Telephone Information Exchange
Service Schedules
Time Table Preparation and Distribution
Maintenance of Schedules
Fare Collection Practices
Auditing of Joint Fares
Accident Prevention Programs
Handling of Complaints
Employee Courtesy Programs
Tie-in Arrangements with Merchants
Special Services Promotion—Football Games, Conventions, Special Party Services, etc.
Off-Peak Trip Promotions, including Shopper Specials and Weekend Tours
Advertising
Tours of Transit Facilities
Demonstration Projects with Federal Assistance
Reduced Fare Experiments

THE FINAL CONSIDERATION in developing promotional policies is adoption of an appropriate set of yardsticks for measuring the overall effectiveness of transportation service. It is not enough to determine the profitability or cost-revenue relationship for each system, although this is a significant measure. Prevailing fiscal/political patterns among transit systems in the Bay Area reflect an interest in more comprehensive transportation barometers.

CHAPTER 1

Introduction

THE CABLE CAR is a fitting symbol for San Francisco, for this is a transit-oriented city. Per capita transit usage is among the highest in the nation—second only to New York and considerably above transit riding in Chicago and Philadelphia, despite the fact that these cities have well-developed rapid transit systems. Unlike its sister city, Los Angeles, San Francisco has turned its back on freeway development; federal aid ranging up to 90% in some instances and amounting to nearly one billion dollars was not enough to gain popular support for various freeway proposals in San Francisco over the past 10 years. On the other hand, voters endorsed the BARTD bond issue for $792 million to finance rapid transit development in November 1962.

On the East Bay side, transit utilization is not so high, but there is a distinct recognition of the need for a more effective Bay crossing. Every morning and evening, access to East Bay communities is controlled by a single gateway—the San Francisco-Oakland Bay Bridge. With downtown San Francisco the principal employment and shopping center, the need for better balance between alternate facilities is apparent. This commuting climate throughout the Bay Area—high transit utilization on the one hand and physical separation imposed by topography on the other—provides an opportunity for optimum transit development, with surface routes effectively complementing the new high-speed rapid transit system.

The Northern California Transit Demonstration Project (NCTDP) was born of the necessity to solve the problems of coordination introduced by this 75-mile rapid transit system to the San Francisco Bay Area. The project was launched in mid-1965 as a joint venture between the two principal surface operations that will be affected by the new system —San Francisco Muncipal Railway (Muni), serving that city locally and the Alameda-Contra Costa Transit District (AC Transit), serving East Bay communities—and the Bay Area Rapid Transit District (BARTD).

Purpose of the Project

Within the context of a previously determined BARTD alignment and station locations, NCTDP has seven objectives for transit coordination in the Bay Area as follows:

1. Develop a coordinated network of routes for the three systems, to best suit projected intra-regional travel desires;
2. Develop a modernization program—directed primarily toward the antiquated Muni system—for rolling stock, physical plant and operational procedures;
3. Develop the best possible methods for passenger transferring and handling of fares at points of interchange between systems;
4. Determine operating costs throughout the proposed network, and develop an equitable revenue-sharing arrangement for the three systems;
5. Develop a system of fares, for both single-vehicle and combination rides, such that proper balance will be achieved between revenues and public service;
6. Determine the impact of BARTD and the proposed coordination program on Muni and AC Transit; and
7. Develop a staging program for the proposed changes and improvements, and for promoting public use of the coordinated system.

This seven-phase program has been accomplished under a prime contract by Simpson & Curtin, Transportation Engineers, the results and recommendations of which formed the basis of this report. Kaiser Engineers performed work under a subcontract for the study of three components of the Muni system in work Phase 2 above—rolling stock, ways and structures, and shops and garages. FMC Corporation, under another subcontract, has analyzed a fourth component of work Phase 2—electrical facilities and power requirements—and also has studied the fare collection and physical interchange of passengers associated with work Phase 3. These subcontractors' recommendations are identified in the appropriate work sections; unless otherwise indicated, the balance of the study is the responsibility of the primary contractor.

In keeping with the demonstration aspect of the Project, the methods and techniques developed for the purpose of achieving specific objectives outlined above also were analyzed for their influence upon transit coordination problems in other metropolitan areas. The Project is mandated to present analytical methods and alternatives to satisfy other general transit conditions as well as the specific requirements in this study area.

SAN FRANCISCO MUNICIPAL RAILWAY

The San Francisco Municipal Railway—Muni—is a passenger transportation utility owned by the City and County of San Francisco and administered as a unit of the city government by the Public Utilities Commission.

Muni is normally governed by a five-member Public Utilities Commission appointed by the Mayor of San Francisco. Major policy decisions regarding the system (level of fares, rerouting of lines, change of equipment, ad valorem tax subsidy, etc.) are subject to approval by the city's 11-member Board of Supervisors, who are elected to four-year terms of office on a staggered basis.

An early provision of the City Charter provided that public utilities, including street railway facilities, were to be acquired by the city for public operation. The Muni owes its beginning to a $2 million bond issue approved in 1909 by the citizens of San Francisco. Throughout the decades which followed, Muni has steadily grown through extensions and acquisitions, until the last of the privately-owned transit lines in San Francisco was purchased in 1952.

The system serves the city of San Francisco with a close grid of 61 lines, arranged so that nine out of ten residents live within two blocks of a Muni route.

The current rolling stock consists of 39 cable cars, 105 PCC streetcars, 360 trolley coaches and 524 motor coaches.

The Study Area

The travel habits of over two million people are involved in the Northern California Transit Demonstration Project study area, which comprises the service territories of the three transit systems under consideration (Figure 1):

- The City of San Francisco, all of which is served by the Muni system;
- Portions of Alameda and Contra Costa Counties served directly by AC Transit;
- Daly City and other communities in northern San Mateo County contiguous to San Francisco, served directly by either Muni or Western Greyhound Lines commuter routes (Greyhound);
- Areas in Alameda and Contra Costa Counties within range of AC Transit or Greyhound commuter routes.

The BARTD system and its service territory lie within this study area.

In 1965, the population of the NCTDP area was 2.28 milion persons. San Francisco and the highly developed portion of the East Bay coastal plain, located between Richmond on the north and Hayward on the south, accounted for 76% of this total.

Area population is projected to reach 2.74 million persons by 1975, representing a gain of 460,000 persons or 20%; the great bulk of this will be experienced in those portions of the study area which are now relatively sparsely developed—southern Alameda County, central Contra Costa County, and sections of northern San Mateo County. For this reason, the study boundaries have been extended beyond the service territory of existing surface transit systems to obtain an adequate measure of trip-making potential in the rapidly growing areas.

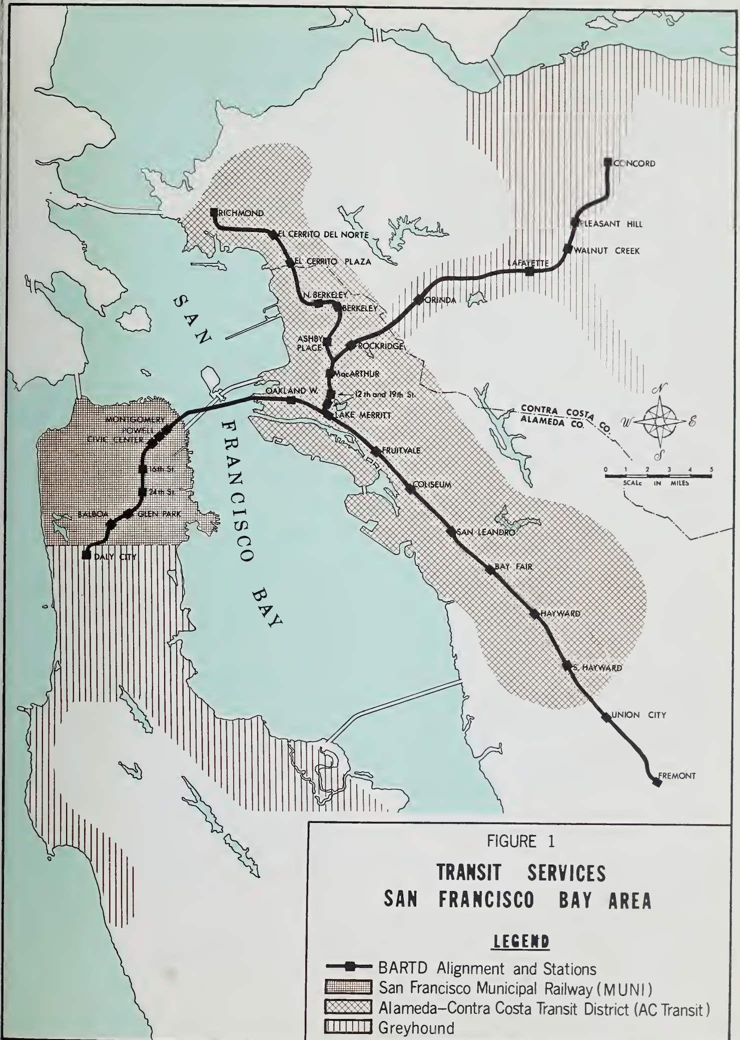


FIGURE 1

TRANSIT SERVICES
SAN FRANCISCO BAY AREA

The study area embraces more than 780 square miles, yielding an aggregate population density of 2,900 persons per square mile. Densities range from highs of 15,500 for the City of San Francisco and 6,900 in the City of Oakland down to only one to two persons per square mile in fringe areas.

From a transportation standpoint, San Francisco is unique in several respects. The city is roughly square in shape, approximately seven miles wide by seven miles deep, with an aggregate area of 47 square miles. It is contained by water on three sides and the San Bruno mountains on most of the fourth. With a residential population of 755,000 and daytime population in excess of one million, this containment accounts for the high density—both residential and commercial—throughout the city. Another topographic feature influencing transportation is the number of hills, nobs and peaks, making for short streets in some sections and circuitous streets in others, with grades frequently in excess of 20%.

The San Francisco CBD is a compact and highly developed center of commercial, retail and civic activities, representing not only the hub of the entire Bay Area but the principal financial, shipping and commercial center for the prosperous West Coast. All of these features combine to make San Francisco highly dependent upon public transportation.

The East Bay portion of the study area divides into two major geographical sections, (1) the coastal plain including more than a dozen incorporated cities and towns strung together in a 40-mile north-south chain varying from three to eight miles in width, and (2) the area east of the Berkeley hills including Lafayette, Walnut Creek, Pleasant Hill, Concord and other communities. The north and south legs of BARTD (Figure 1) serve the coastal plain from Richmond south to Fremont, while the east leg is being tunneled through the Berkeley hills to tap the fast-growing region to the east. These converge in Oakland with the west leg extending across the Bay to San Francisco.

ALAMEDA-CONTRA COSTA TRANSIT DISTRICT

The Alameda-Contra Costa Transit District is a public agency, created by the voters in 1956 pursuant to Part I, Division 10, Public Utilities Code of the State of California. It became an operating entity on October 1, 1960 when it acquired the assets of Key System Transit Lines, a private corporation.

Alameda-Contra Costa Transit District is governed by a Board of Directors consisting of seven members elected to office for terms of four years on a staggered basis.

Boundaries of the service district embrace parts of Alameda and Contra Costa Counties, consisting of 11 cities and several unincorporated areas in the East Bay, extending from San Pablo and Richmond on the north, through El Cerrito, Albany, Berkeley, Emeryville, Oakland, Piedmont, Alameda, San Leandro, and including Hayward to the south.

Approximately one million people reside within the service district which includes 150 square miles.

Alameda-Contra Costa Transit District furnishes local and express bus service within the East Bay area and connects the East Bay area with San Francisco, operating over the San Francisco-Oakland Bay Bridge, to a downtown terminal at First and Mission Streets.

The current fleet consists of 685 buses, including over 400 'new look' buses placed in service since October 1, 1960.

The Planning-Analysis Process

The task of analyzing and planning the coordinated transit needs for the future Bay Area is at once direct and complex. Direct because of the clarity and imminence of the goals—an integrated network of routes feeding the billion dollar BARTD system while serving the area travel needs. Complex because of the changes in urban fabric which will be brought about by the first completely new rapid transit system in this country in 60 years. For, just as transportation is influenced by the spatial arrangement of homes, commerce and industry, so may transportation influence the accessibility, and hence, desirability of land.

Transportation goes where the jobs and people are. Recent developments, such as the Toronto Subway and the urban freeway system, have shown that the opposite is also true—the directions of urban development can be molded by a transportation system. A side effect on urban social considerations recently spotlighted is the ability of public transit to reconnect low-income minority groups living in the older sections of cities with 'blue collar' industries which have moved away to suburban industrial parks.

Recognition of the complexity of such interactions and the need for a planning tool which is sensitive to these factors gives rise to the attempt to measure the "total problem" and all its facets. This comprehensive approach is the essence of systems analysis, the much-discussed technique used to master the complex problems of the nation's aerospace and defense activities. The popularity of this approach has grown with availability of high-speed computers and the recognition of the many problems interrelating urban transportation and metropolitan environment.

However, the principal advantage of this tool also invites a hazard. The speed and ease with which modern computers ingest large volumes of data have lured analysts into using computer programs which seemingly eliminate the need for human judgment—raw data are the only required input, and after several seconds of blinking lights and revolving tapes, the printer clatters out the solutions to the problem. This "cook book" approach is attractive in that all required input can be carefully defined and specified.

NCTDP has enlarged the total systems approach, however, to permit a closer personal scrutiny of the processes involved in predicting transit travel and the resultant network loading. A series of sub-systems has been devised to allow for examination of results and interjection of judgment and policy at crucial interim steps in the process. This process of partial analysis and evaluation of alternatives for the several sub-systems—traffic, routes, costs and revenues—was accomplished by circulating technical memoranda among the operating agencies and other principals.

Fundamentally, the approach relies upon the premise that travel within the urban area is habitual, measurable and rational. The daily journey to work, as well as travel for other purposes, is sufficiently regular and logical that it can be quantified accurately in mathematical terms. It is this orderliness in travel which permits transportation plans to be prepared and tested against a set of predetermined goals and standards. The planning tools developed

SAN FRANCISCO BAY AREA RAPID TRANSIT DISTRICT

The San Francisco Bay Area Rapid Transit District was created by an act of the California State Legislature in June 1957.

On November 6, 1962 the voters approved issuance of $792 million in general obligation bonds to finance construction of the system.

The government of the district is vested in a Board of Directors consisting of 12 members, representing the three counties in the District —Alameda, Contra Costa and City and County of San Francisco.

The rapid transit system, as it is being constructed, provides for high-speed, automatically controlled trains, operating over 75 miles of completely grade-separated, double tracks, including some 23 miles of underground constructions (subways, tunnels and four miles of subaqueous tube) and 25 miles of aerial construction, with the balance at grade.

The route is laid out in four segments, all connected and radiating from the central business district of Oakland. One segment connects via tube under the San Francisco Bay with the Central Business District of San Francisco and extends to Daly City at the southerly city limits of San Francisco. Another segment extends south and east, through East Oakland, San Leandro, Hayward, Union City and terminates in the city of Fremont. The northern segment extends through the cities of Berkeley, Albany and El Cerrito and terminates in the central business district of Richmond, and the fourth segment extends through the hills above Oakland into Contra Costa County, serving the communities of Orinda, Lafayette, Walnut Creek and Pleasant Hill and terminates at Concord.

The system, as designed, will have 33 stations; parking facilities will be provided at 23 of these in outlying areas.

The first phase of the service is scheduled to be in operation late in 1969, with the balance of the system scheduled for completion and operation by 1971.

through this approach are signally suited to provide the quantitative evaluations required to support value judgments in the selection of elements of the total coordinated plan.

Essentially, the planning process comprises three stages: forecasting urban development, simulating the transportation consequences of the projected urban growth, and measuring the impact of increased transportation demands on the proposed transit systems.

Data Collection

Inventories of existing conditions involved three basic areas of investigation (Figure 2)—transportation facilities, land use and travel. The characteristics of transit routes throughout the area were obtained from the operating companies and supplemented by field checks. These data included route locations, running time, headways and other operating information. Similar data—travel times, distances, operating speeds, etc.—for the highway network were obtained from the California Division of Highways.[1]

The foundations for determining why people travel were constructed from the present population, land use and economic activity within the NCTDP area. These demographic data were collected by the 1960 Federal Census, the Arthur D. Little *San Francisco Community Renewal Program*[2] and other Bay Area planning agencies.

To gain an accurate picture of the current transit travel market, the Project conducted the most extensive transit rider origin-destination study in the history of the Bay Area, reaching more than a quarter of a million riders. This survey—supplemented by information provided by Muni and AC Transit—afforded a comprehensive picture of current travel patterns of Bay Area tripmakers. Complementary travel data for highway users were obtained from the California Division of Highways.

Analysis and Forecasting

The first step in the analytical process was determination of the underlying factors which cause present travel. These factors emerged through the use of multiple regression analysis. Relying on the hypothesis that measurable relations exist among travel, the transportation system, and the land use it serves, the process provided a foundation upon which estimates of future transit usage were based—the number and location of people and jobs anticipated for 1975.

The NCTDP study objectives were accomplished by calibration of a *forecasting model* designed through the procedure set forth in Chapter 8. These tripmaking equations were tested by comparing synthetic trips derived by the model with actual results from field checks. By testing its accuracy against specified historical facts at various stages of the total planning process, confidence was attained in the ability of this method to reproduce future transportation desires. With existing relationships established and validated, the model was adapted to future urban growth circumstances for the Bay Area in order to develop the projected travel distribution.

Plan Development—With estimates of the 1975 Bay Area population and travel demands at hand, it was possible to tailor an initial coordinated transit test plan for needs of 1975 travelers, as described in Chapter 10. This first test network was coded for machine simulation, revealing the travel demands on each route in the system. Alternate layouts of rapid and surface transit routes were developed, then tested by superimposing the matrix of travel desires on each route system to obtain a 'loaded network.'

Fare Formulas

A corollary phase in coordinating Bay Area transit facilities was the definition of fare policies governing revenue yields and public attitudes of existing transit operations, as set forth in Chapter 5, and the modifications to expand these fare programs to a regional system. Future travel demands provided the user estimates for each of the related systems, guiding the planning of fare structures to best serve the major travel categories.

Inasmuch as fares have a direct influence on patronage, it was necessary to relate combination fares for the access trip and rapid transit

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[1] Simpson & Curtin, *Technical Memorandum No. 12: Highway System Characteristics*, February, 1966.

[2] Arthur D. Little, Inc. and San Francisco Department of City Planning, *San Francisco Fact Book*, CRP: San Francisco Community Renewal Program.

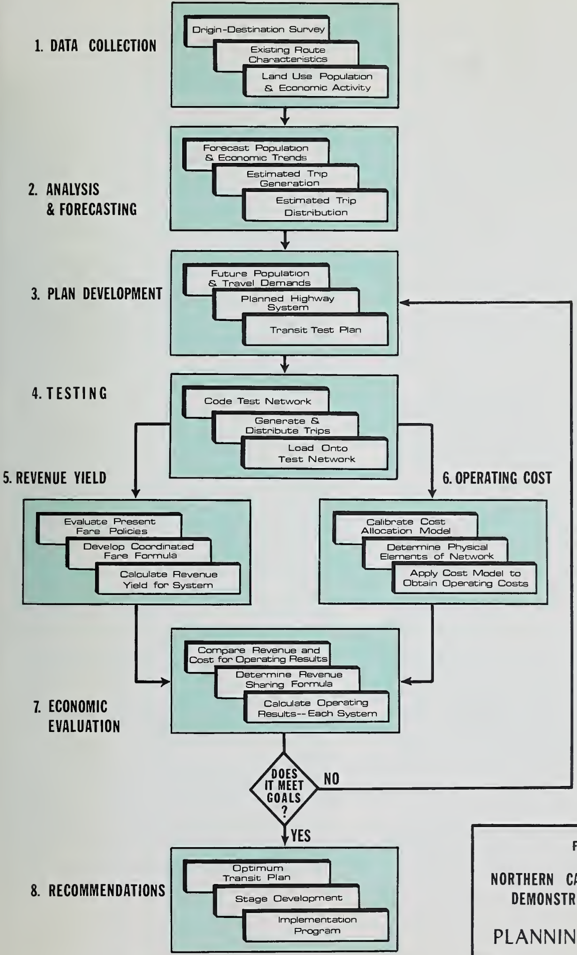
1. DATA COLLECTION
Origin-Destination Survey
Existing Route Characteristics
Land Use Population & Economic Activity
2. ANALYSIS & FORECASTING
Forecast Population & Economic Trends
Estimated Trip Generation
Estimated Trip Distribution
3. PLAN DEVELOPMENT
Future Population & Travel Demands
Planned Highway System
Transit Test Plan
4. TESTING
Code Test Network
Generate & Distribute Trips
Load Onto Test Network
5. REVENUE YIELD
Evaluate Present Fare Policies
Develop Coordinated Fare Formula
Calculate Revenue Yield for System
6. OPERATING COST
Calibrate Cost Allocation Model
Determine Physical Elements of Network
Apply Cost Model to Obtain Operating Costs
7. ECONOMIC EVALUATION
Compare Revenue and Cost for Operating Results
Determine Revenue Sharing Formula
Calculate Operating Results-- Each System
DOES IT MEET GOALS ?
NO
YES
8. RECOMMENDATIONS
Optimum Transit Plan
Stage Development
Implementation Program

FIGURE 2

NORTHERN CALIFORNIA TRANSIT DEMONSTRATION PROJECT

PLANNING PROCESS

leg of each journey under various fare proposals to existing fare levels. Alternate proposals were developed for length of ride, as detailed in Chapter 12, with discounts for feeder trips and flat fares within each city to preserve existing fare patterns. Electronic data processing permitted calculation of the total revenue yield from these fare plan alternatives, giving recognition to the elasticity of transit use with rider costs.

The fare formulas were refined further for sharing of revenues by the surface and rapid transit systems in the Bay Area in accordance with number of journeys making such combination rides in various fare categories. Prospective revenues under the coordinated fare formula are developed in Chapter 12.

Cost Allocation Model

To achieve the segregation of operating costs for each route in the coordinated network, a *cost allocation model* was developed by investigating the relationship between detailed operating expense account items and those operating variables (vehicle need, hours operated, etc.) which best explain each such expense item.

This phase of planning produced an analysis "loop" among Chapters 10, 12 and 13, in that the technique for refining the initial test network was circular. The revenue-cost evaluation demonstrated operating economies to be realized by reroutings; rerouting altered the coordinated route network which in turn generated new travel demands; a re-evaluation of the revenue-cost framework then determined the advisability of the route changes. Several sets of routings and fare plans were tested by this procedure to provide the coordinated transit plan which optimized public service while maintaining a reasonable balance between revenues and costs.

Plan Evaluation

The combination fare model and its corollary, the cost allocation model, are perhaps the most significant contributions of NCTDP to systems analysis in the transit planning process. The loaded network, developed as a measured correlation of revenue passenger statistics with physical route characteristics, is employed regularly in contemporary urban transportation studies as a realistic basis for the economic evaluation of transit systems. However, a gap has existed between this and the feasibility considerations normally utilized by transit management. These fiscal measures are provided by the route-by-route revenue-cost analyses yielded under the combination fare and cost allocation models (Chapters 12 and 13), thereby extending the planning process through the fiscal operations studies normally performed by transit management.

With the justification provided by the cost allocation model, the coordinated system is outlined in Chapter 15 which best meets the *raison d'etre* of public transit—optimum service to the patron within a viable economic framework.

Table 1

TREND OF TRANSIT REVENUE PASSENGERS

MUNI and ACCTD in Relation to Transit Industry

	Transit Industry (Millions) (a)	MUNI (Thousands)	ACCTD (Thousands) (b)
1950	13,845	183,420	95,566
1955	9,189	144,693	54,818
1960	7,521	141,589	47,169 (b)
1961	7,242	141,612	48,837
1962	7,122	141,886	51,055
1963	6,915	141,561	51,923
1964	6,854	142,585	52,768
1965	6,798	142,747	51,357
1966	6,661 (c)	146,544	51,861
Percent Change:			
1950 to 1960	—45.7%	—22.8%	—50.6% (b)
1960 to 1966	—11.4	+ 3.5	+ 9.9

(a) Source: American Transit Association.

(b) Transit District took over operations of Key System on October 1, 1960.

(c) Preliminary report.

CHAPTER 2

Present Transit Travel

MUNI carried more than 146 million revenue passengers in 1966, while AC Transit aggregated nearly 52 million revenue rides. Total patronage on the two principal Bay Area local transit systems approximates one-fifth of a billion rides annually. This is a measure of the vigor of transit in the San Francisco and Oakland areas.

In the decade of 1960's, there has been a marked divergence in the trend of transit riding in the Bay Area as compared with the national trend. Transit riding throughout the country has continued to decline, although at a somewhat lesser rate than in the prior decade, with relative stability achieved only in the last year or two on some of the larger systems (Table 1). In the years 1960-66, the aggregate decline in the industry was 11.4%. Muni had a remarkably stable level of riding during the years 1960 to 1965. In 1966, riding was up—the first appreciable variation in this decade. Aggregate rides on the San Francisco system in 1966 were 3.5% above the 1960 total and slightly above the 1955 level.

In the East Bay area, the Alameda-Contra Costa Transit District took over from Key System on October 1, 1960: the record from that time has been one of expanding operations and growing passenger traffic. Between 1960 and 1966, the AC total passenger traffic increased by nearly 10%, a percentage *gain* comparable to the *decrease* for the transit industry as a whole over the same years.

Many factors contributed to the growth of Muni and AC Transit riding during this period when the trend in the industry was generally declining. An important element was the fact that the Muni system maintained service at virtually the same level through these years, while AC Transit added a substantial amount of new service. This increase in mileage was followed by a gain in passenger riding on the AC system. The AC system was aided, also, by major expenditures for new equipment, the addition of new express operations and aggressive promotion.

In addition to the level of service, another factor in the recent upward trend of transit riding in the Bay Area has been the fare policy followed by these two publicly owned systems. The City of San Francisco has adopted a policy of supplementing the fare box by payments from general funds; AC Transit also is making use of tax moneys. As a result, both systems have been able to maintain fare structures lower than prevailing on major transit properties elsewhere.

Transit Riding Habit

The San Francisco Municipal Railway carried 146.5 million revenue passengers in the year 1966. The Muni system serves a total population of approximately 764,000 people, so that the "transit riding habit" was 191.8.[1]

The AC Transit District carried 51.9 million revenue riders in the same year in relation to an aggregate population of 950,000. This indicates a transit riding habit of 54.6.

The Muni riding habit is one of the highest in the nation (Table 2). Only the New York City transit system produces a higher ratio, and this city has an extensive rapid transit system.

Another measure of relative transit use is the percentage of workers using public transportation for home-to-work travel. By this yardstick, the major rapid transit cities—New York, Philadelphia, Boston and Chicago—top the list (Table 3). However, with nearly 37% of San Francisco workers using public transit, this city is already close to the 40% level prevailing in Philadelphia, Boston and Chicago.

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[1] Transit riding habit represents the number of times that each person in the area used the transit service for a one-way trip, computed on an average basis over the entire population served.

Pattern of Present Transit Travel

The two major transit systems serving the Bay Area carry more than one-half million adult riders on an average weekday. The major share of this is on the Muni system, with 409,000 daily riders; AC Transit carries 125,400 weekday passengers.

Home-to-work travel is the dominant purpose of transit usage on both the Muni and AC Transit systems. This applies both to local and transbay journeys—two out of every three transit trips are between home and work (Table 4). The San Francisco CBD is the focus of transit travel for the entire Bay Area, with six out of 10 trips destined for this dense commercial hub. The proportion of work trips to downtown is significantly higher than for the study area as a whole—almost three-quarters of the CBD transit trips are work trips.

Table 2

TRANSIT RIDING HABIT

Transit Systems Serving Metropolitan Areas of Over One Million Population

Principal Cities Served (a)	Annual Revenue Passengers (thousands) (1)	Population Served (thousands) (2)	Transit Riding Habit (1)÷(2)
New York	2,269,397	7,782	291.6
SAN FRANCISCO	146,544	764	191.8
Boston	265,695	1,500	177.1
Chicago	515,386	3,950	130.5
Washington	139,478	1,165	119.7
Philadelphia	282,497	2,801	100.9
Milwaukee	87,635	1,003	87.4
Baltimore	95,638	1,185	80.7
Buffalo	48,993	645 (b)	76.0
Atlanta	52,003	687	75.7
Los Angeles	139,796	2,104 (b)	66.4
Detroit	127,128	1,992	63.8
Seattle	34,994	550	63.6
Pittsburgh	96,822	1,629	59.4
OAKLAND	51,861	950	54.6
Minneapolis	61,787	1,200	51.5
Cincinnati	34,563	728	47.5
Dallas	31,411	680	46.2
Kansas City	24,353	700	34.8
San Diego	14,987	575	26.1

(a) Passenger data or population served not reported by transit systems serving Cleveland, Houston, and St. Louis. Passenger data shown are those for the latest calendar year reported to date, in most instances the year 1966.

(b) Population of largest city served. Total population served not reported.

Table 3

POPULATION DENSITY AND TRANSIT USE FOR HOME-TO-WORK TRAVEL

City	Population Per Square Mile of Land Area Within City Boundaries	Percent of Workers Using Public Transportation to Work
New York	24,697	61.0%
Philadelphia	15,743	41.2
Boston	14,586	40.0
Chicago	15,836	39.5
Washington	12,442	37.8
SAN FRANCISCO	15,553	36.8
Pittsburgh	11,171	32.1
Cleveland	10,789	30.0
St. Louis	12,296	29.3
Milwaukee	8,137	28.4
Baltimore	11,886	28.0
Atlanta	3,802	27.9
Buffalo	13,522	26.7
Cincinnati	6,501	22.3
Detroit	11,964	21.6
Minneapolis	8,546	21.3
Kansas City	3,664	18.6
Seattle	6,295	17.9
Dallas	2,428	15.6
OAKLAND	6,935	15.2
Los Angeles	5,451	13.1
Houston	2,860	12.5
San Diego	2,979	7.8

Source: United States Census, 1960.

Transbay Transit Travel

Four principal East Bay cities—Oakland, Berkeley, Alameda and Richmond—generate over 20,000 transit rides daily to and from downtown San Francisco (Figure 4.) Oakland is the largest single production area, originating nearly 9,800 of these journeys.

Altogether, there are 27,040 daily trips using AC Transit and Greyhound vehicles from East Bay communities to downtown San Francisco. Another 14,555 transbay bus trips go to sections of San Francisco outside the CBD: downtown trips are 65% of the total 41,595 transbay trips.

The destinations of transbay riders within the Central Business District of San Francisco are concentrated in the densely developed financial district along Montgomery Street (Figure 5).

The pattern of travel to downtown blocks for Greyhound riders is much like the corresponding chart for AC Transit. Major trip destinations are clustered in the financial district and along Market Street. Relatively few of these riders are delivered within easy walking distance of their ultimate destinations.

It is noteworthy that the San Francisco CBD attracts more East Bay riders than the Oakland CBD—27,040 compared to 23,200. However, as shown later in the analysis of trip purpose, a considerably greater proportion of transit riders to downtown Oakland are shoppers—11%, as compared to only 3% of transit riders across the Bay to downtown San Francisco classified as shopping trips.

Access to Bus Routes—Six out of 10 AC Transit transbay riders walk to the bus. This is lower than the proportion on local service; on local East Bay lines, eight out of 10 riders walk to their boarding stops. For each type of Muni service in San Francisco, the same proportion of walkers (80% of transit passengers) also applies, as shown on Table 5.

Perhaps more significant is the correspondingly higher proportion of transbay riders using automobiles to get to their boarding stops. More than 20% of transbay riders either drove or were driven by others to the bus stops, whereas of Muni and AC Transit local riders, only 5% and 6%, respectively, are in this category.

Attention should be paid to the fact that a significant portion of transbay patrons—15% more than systemwide riders—use automobiles to reach bus lines, yet choose not to drive all the way to San Francisco. In their choice of transbay mode, these present transit patrons have demonstrated that a service which transports them for considerable distances quickly and conveniently to the San Francisco CBD destinations will attract patronage. The use

FIGURE 3

POPULATION DENSITY AND TRANSIT WORK TRAVEL

THIRTY LARGEST U.S. CITIES

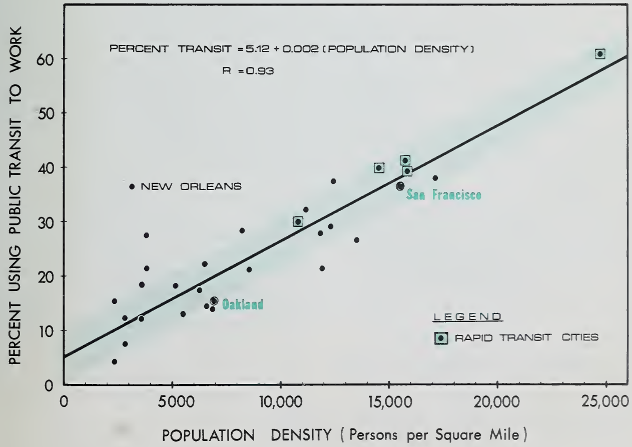


Table 4

STUDY AREA TRANSIT TRAVEL
1965 Average Daily Traffic

Trip Purpose	Transit Trip Attractions: San Francisco CBD (1)	Transit Trip Attractions: Total Study Area (2)	Percent San Francisco CBD (1) ÷ (2)	Percent by Trip Purpose: SF CBD	Percent by Trip Purpose: Total
Home-based-work	229,670	356,990	64.3%	73.3%	66.8%
Home-based-shop	14,660	25,740	57.0	4.7	4.8
Home-based-other	27,350	78,440	34.9	8.7	14.7
Non-home-based	41,810	73,560	56.9	13.3	13.7
TOTAL	313,490	534,730 (a)	58.6%	100.0%	100.0%

(a) Since many transit riders use more than one local system, this total will not equal the sum of revenue passengers on each system.

of one mode of transportation over another is related to the distance involved and the time required in moving between points. This suggests that, to the extent a coordinated BARTD-Muni-AC Transit system will improve the speed, comfort and convenience of transit riding, more automobile drivers can be influenced to switch to transit.

Confirmation of this is indicated by the trend of transbay riding in recent years as compared with the picture on local East Bay lines. Transbay riding is up 8% from two years ago, whereas riding on the AC Transit local lines has declined. It is significant that the transbay service has increased both in amount and speed of operation; the commuter lines from East Bay to downtown San Francisco now average over 22 miles per hour—more than twice the speed of local routes.

A parallel in the attractiveness of faster transit service to displace auto usage may also be drawn from Muni streetcar routes in comparison with other parts of the system. Streetcar routes K, L and M converge upon the Twin Peaks Tunnel from different parts of southwest San Francisco. From that point to downtown, the streetcars travel just as rapidly as automobile traffic—in some instances faster. It is notable that 8% of riders of these streetcars use private automobiles to reach the transit stops, compared with the Muni systemwide average of 5%, with most of this auto access occurring west of the Twin Peaks Tunnel.

Approximately 12% of cable car riders use automobiles as a means of reaching this service. In addition to some commuters parking at the outer ends of cable car routes, this figure is weighted by the large number of tourists who leave their automobiles to ride the cable cars.

Travel Means to Destinations—The proportion of transbay transit riders walking to work from the Transbay Terminal exceeds those using Muni by a significant margin (Table 6).

About 66% of local riders (with East Bay destinations) walk and 32% transfer to another bus route to reach their destinations. This is a somewhat greater proportion of walkers than in the transbay service.

A fundamental difference in directness of service underlies these patterns. The transbay routes have only one alighting "stop" in San Francisco, the Transbay Terminal. Less than six out of ten transbay riders are within walking distance of their destinations at the Terminal; the other four must (or choose to) complete their trips on Muni. By contrast, AC Transit local routes serving the Oakland CBD are not, of course, limited to a single alighting stop. It should be noted that transbay BARTD riders will be able to alight from trains at three Market Street locations in the San Francisco CBD: Montgomery Street, Powell Street and the Civic Center.

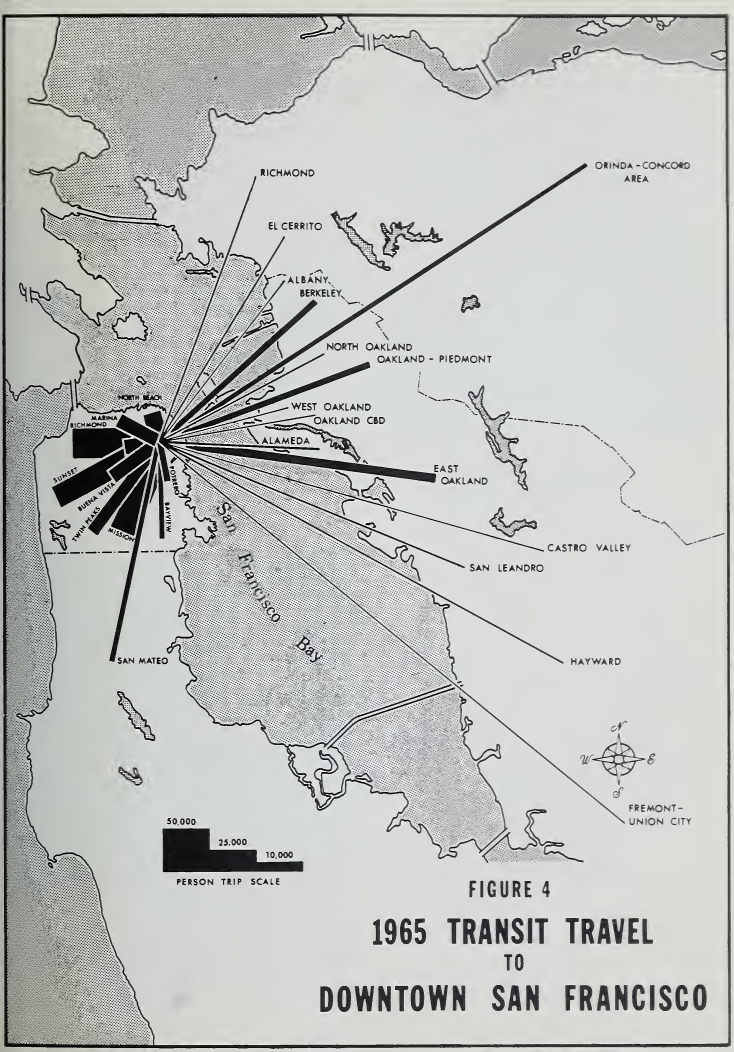
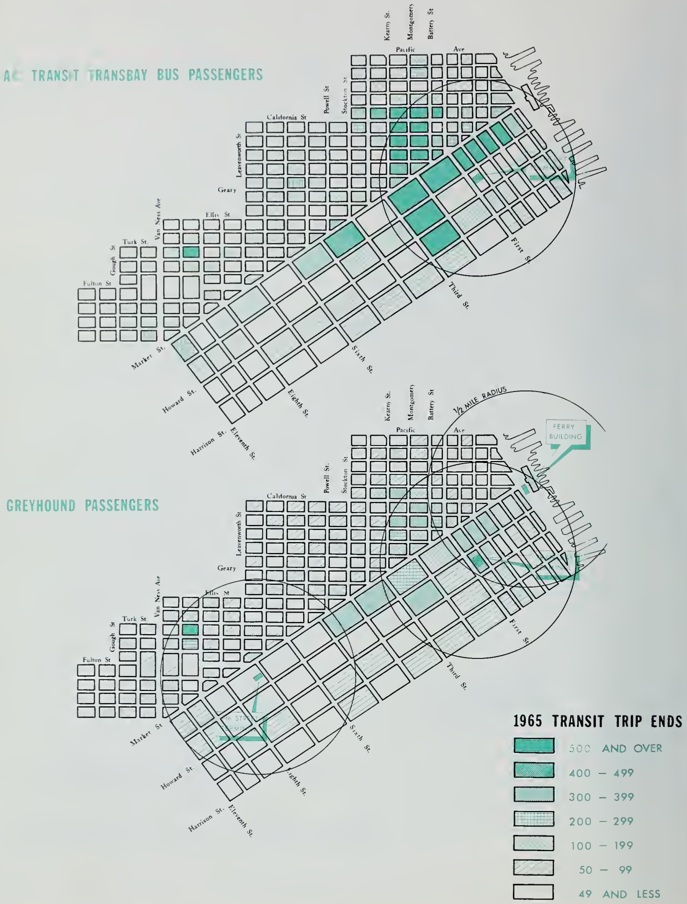


FIGURE 4

1965 TRANSIT TRAVEL
TO
DOWNTOWN SAN FRANCISCO

FIGURE 5

DOWNTOWN DESTINATIONS



The ride-walk and ride-transfer patterns vary for similar reasons on the most heavily used types of Muni service—streetcar vs. bus or trolley coach. Relatively more streetcar riders walk to complete their trips. This is explained by differences in route functions. Each of the five streetcar lines serves the core of the CBD—Market Street—for most of its length. Although most bus and trolley coach routes terminate in the CBD, relatively fewer of these provide service along the area's Market Street spine.

The proportion of cable car riders transferring to other vehicles (27%) is low in relation to the systemwide average of about 35%. This reflects the fact that many cable car riders (tourists, etc.) make complete round trips with no destinations other than those along and at the ends of cable car routes.

As expected, the rate of transferring from the two shoppers' special routes was lowest of all—22%. These routes are intended to provide direct service to main points of shopping interest in the CBD. Passengers wishing to transfer from the shoppers' shuttle to other lines must pay the regular fare on the second Muni route. There are no transfer rights.

Table 5

MEANS OF TRAVEL TO TRANSIT VEHICLES

1965 ADT

Type of Service	Percent of Riders Reaching Transit Stop By: Walk	Automobile	Other	Total
AC TRANSIT				
Local	85.2%	6.1%	8.7%	100.0%
Transbay	65.2	20.4 (a)	14.4	100.0
Total	78.5%	10.9%	10.6%	100.0%
MUNI				
Streetcars	79.8%	8.0%	12.2%	100.0%
Cable Cars	76.3	11.5	12.2	100.0
Buses & Trolley Coaches	82.5	4.6	12.9	100.0
Shoppers' Special	82.1	3.7	14.2	100.0
Total	81.8%	5.3%	12.9%	100.0%
TOTAL	80.8%	7.0%	12.2%	100.0%

(a) Includes 12.3 percent automobile drivers, 8.1 percent automobile passengers.

Table 6

MEANS OF TRAVEL FROM TRANSIT VEHICLES

1965 ADT

Type of Service	Percent of Riders Reaching Destination By: Walk	Other Transit	Other	Total
AC TRANSIT				
Local	65.6%	32.4%	2.0%	100.0%
Transbay	58.0	38.5	2.5	100.0
Total	62.9%	34.5%	2.6%	100.0%
MUNI				
Streetcars	66.9%	31.2%	1.9%	100.0%
Cable Cars	65.0	26.7	8.3	100.0
Buses & Trolley Coaches	60.6	37.4	2.0	100.0
Shoppers' Special	76.5	22.1	1.4	100.0
Total	61.9%	35.9%	2.2%	100.0%
TOTAL	62.3%	35.4%	2.3%	100.0%

Transit Riding To and From Downtown Oakland

Downtown Oakland attracts 23,200 transit rides from East Bay communities on the average weekday. This figure represents 25% of the estimated 91,720 average weekday adult trips on AC Transit local routes. The "reverse flow" of travelers who reside in San Francisco and work in downtown Oakland is comparatively minor (Figure 6).

More than six out of 10 riders destined for the Oakland CBD start their trips within Oakland itself. Another one out of 10 begins from Berkeley, while one more out of 10 travels from Alameda (city). San Leandro accounts for the greatest number of the remaining riders, followed by Hayward, Piedmont, Richmond, El Cerrito, Castro Valley, Albany and Emeryville.

More than 80% of riders use only one AC Transit local bus to reach the Oakland CBD. Approximately three-quarters of the patrons walk both to and from the inbound bus (Tables 5 and 6). These characteristics reflect the fact that present coverage of the East Bay area is widespread and convenient. Automobile riding to reach the local bus is relatively greater in communities farthest from the Oakland CBD: Castro Valley, Hayward, Richmond, and San Leandro.

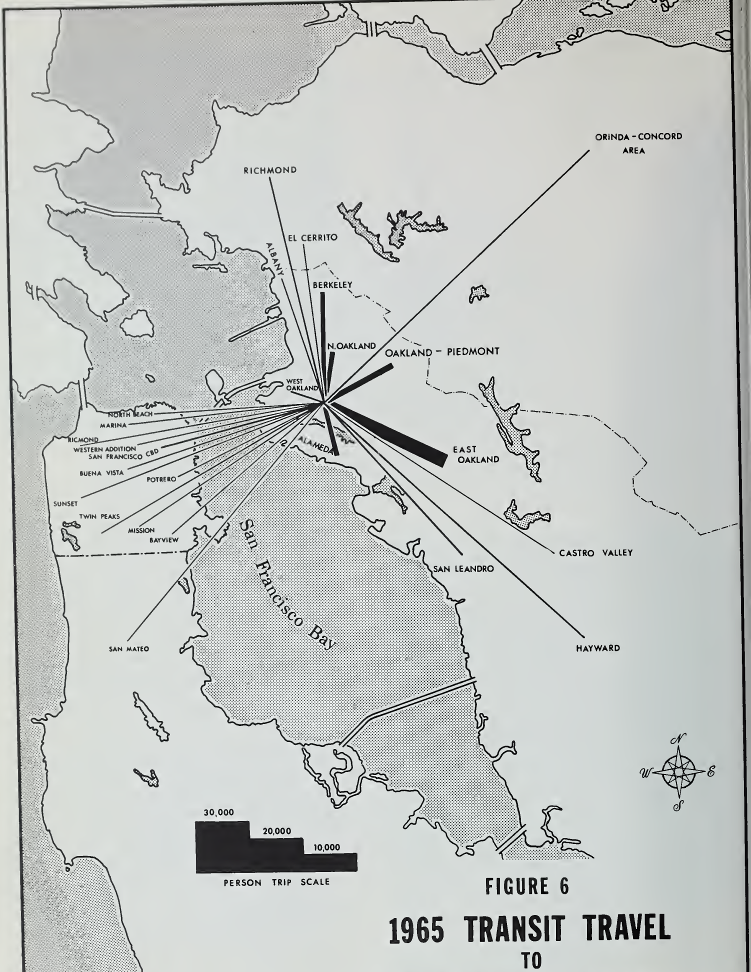


FIGURE 6

1965 TRANSIT TRAVEL TO DOWNTOWN OAKLAND

About 19% of local transit riders destined for Oakland's CBD transfer from one local bus to another. Although 80% of total inbound trips originate in Oakland, Berkeley and Alameda, these communities account for about 90% of all transfer trips. Service density in these communities is high, so that riders not provided one-vehicle service to the CBD are more likely to be within reasonable walking distance of a connecting route.

Transit Corridors to Downtown San Francisco

The San Francisco CBD exerts relatively twice the attraction for Muni riders as does the Oakland CBD for AC Transit local riders. Approximately 209,000 Muni passengers enter and leave downtown San Francisco daily; this represents more than half of Muni's average weekday ridership of 409,000 adult passengers.

Of all intracity trips destined for downtown San Francisco, more originate within the CBD itself—20% of the total—than in any other district of the city. Most of these are work-related, personal business or shopping trips made by persons who have already made an inbound trip to the CBD from another part of the city.

The densely populated Richmond District accounts for the largest number of trips (33,378) from residential districts to the CBD, followed by Sunset (24,482) and Mission (28,746). The latter corridor will be served well by the proposed BARTD alignment (Figure 7). The remaining districts each account for less than 10% of CBD-bound Muni riders.

More than two out of three CBD-bound Muni riders walk both to and from the transit vehicle (Table 7). About one out of three either transfers or uses an automobile to reach a vehicle heading downtown; most of these are transfer riders. The Bayshore District is the only area in the city from which transfer trips exceed walk-to, walk-from trips; only three through routes bound for the CBD serve this area.

Downtown Destinations of Muni Riders. Figure 8 illustrates the location of major transit trip generators by downtown blocks. Several areas of activity stand out on this chart: the density of travel strung along Market Street from the Bay to Van Ness Avenue (which accounts for the low transfer rates from streetcars to destinations); the concentration of trips to the financial center. Another major travel axis is revealed along the "Post-Geary" corridor, with lesser travel volume destined for the Government Center surrounding City Hall.

External Transit Trips

Downtown San Francisco attracts over 17,000 bus trips daily from West Bay areas outside of the city (San Mateo and Marin Counties). As might be expected, automobile usage is the dominant means for these commuters to reach the transit vehicles; over 70% drive or are driven to the bus stop. As in the case of transbay riders, the fact that bus travel is nearly as fast as automobile offers a strong inducement for these commuters to leave their cars outside the city and complete their journeys to downtown San Francisco by transit.

Trip Purpose

Work-related trips clearly account for the majority of transit rides on both the Muni and AC systems (Figure 10 and Table 8).

However, there are distinct differences between the characteristics of transbay riders and

Table 7

SAN FRANCISCO ORIGINS
OF MUNI RIDERS TO DOWNTOWN

	1965 Average Daily Trips			
Originating Area	Walk-to Walk-from	Auto-to, No Transfer	Transfer Trips	Total Trips
CBD	24,458	2,160	8,366	34,984
Richmond	24,872	1,010	7,496	33,378
Mission	18,476	1,310	8,960	28,746
Sunset	17,030	1,382	6,070	24,482
Buena Vista	12,374	854	3,932	17,160
Russian Hill-North Beach	11,134	498	4,524	16,156
Marina	9,670	354	4,566	14,590
Western Addition	10,004	240	3,326	13,570
Twin Peaks	6,148	1,270	3,842	11,260
Potrero	3,942	404	3,376	7,722
Bayshore	2,836	378	3,424	6,638
Total	140,954	9,860	57,882	208,696
PERCENT OF TOTAL TRIPS	67.6%	4.7%	27.7%	100.0%

local riders. Eight out of 10 transbay riders are making work-related trips; on the AC Transit local routes, however, only six out of 10 are traveling to and from work. The proportion of shopping travel on AC Transit local lines is nearly 11%—three times as much as on transbay routes (Figure 10). Also, there are twice as many riders on local lines making personal business trips.

These differences indicate that the San Francisco CBD is a more powerful magnet transit-wise for employment than for shopping and other personal activities among East Bay residents.

Another conclusion appears to be that the time advantages of auto travel over bus usage are lessened in peak periods, while travel cost differences are increased. This means that bus usage is more attractive to the regular transbay commuter than to the occasional shopper.

On Muni bus and trolley coach and streetcar routes, the patterns of trip purposes with respect to work, shopping, personal business and social-recreation are nearly identical. About seven out of 10 riders are making work-related trips; another one is shopping; slightly more than one out of 10 are on personal business;

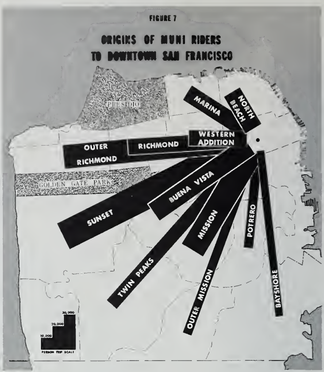


FIGURE 7

ORIGINS OF MUNI RIDERS TO DOWNTOWN SAN FRANCISCO

Table 8

TRIP PURPOSE OF TRANSIT RIDERS

Type of Service	Work	Shopping	Personal Business	Social Recreational	Other	Total
	Percent of Transit Trips For:					
AC TRANSIT						
Local	61.1%	11.0%	13.5%	4.2%	10.2%	100.0%
Transbay	80.4	3.3	6.7	5.9	3.7	100.0
Total	67.5%	8.4%	11.2%	4.8%	8.1%	100.0%
MUNI						
Streetcars	70.8%	8.2%	11.4%	4.4%	5.2%	100.0%
Cable Cars						
Mason & Hyde	44.8	9.2	9.2	31.4	5.4	100.0
California	72.5	6.2	10.6	8.2	2.5	100.0
Buses & Trolley Coaches	72.2	6.9	11.1	4.1	5.7	100.0
Shoppers' Special	22.7	47.3	21.0	4.0	5.0	100.0
Total	70.8%	7.6%	11.2%	4.8%	5.6%	100.0%
TOTAL	69.8%	7.8%	11.2%	4.8%	6.4%	100.0%

while relatively few riders use transit for social-recreational trips. The patterns of trip purposes on the cable car and shoppers' special routes are significantly different. The Mason and Hyde cable cars exhibit the only substantial degree of social-recreational use on either transit system—more than 30%. "Recreation" is a characteristic of the ride itself as well as the attractions served by the routes.

Of interest also is the fact that on the California cable car route, which serves the heart of the financial district, the pattern of trip purposes does *not* differ significantly from the overall Muni pattern, with 70% of trips related to work and only about 8% related to social-recreation.

Nearly half of the shoppers' special riders are indeed shoppers (Figure 10). About two riders out of 10 are making work-related trips, while another two of 10 are on personal business.

Auto Ownership and Availability

On an overall basis, approximately two-thirds of AC Transit system riders are 'captive,' that is, they do not have an automobile available for the trips made by transit—reflecting intra-family competition for use of the car (Table 9). This is a somewhat more meaningful figure than the 38% of riders from households with zero car ownership.

Table 9
AUTO OWNERSHIP AND AVAILABILITY
1965

	East Bay Transit Riders		
Autos Owned	% of Riders	% with Auto Available	% Without Auto Available
0	37.9%	3.6%	96.4%
1	47.4	45.7	54.3
2	12.3	59.7	40.3
More than 2	2.4	61.8	36.2
TOTAL	100.0%	31.9%	68.1%
	San Francisco Transit Riders		
Autos Owned			
0	34.7%	3.3%	96.7%
1	47.3	44.6	55.4
2	14.9	61.2	38.8
More than 2	3.1	62.0	38.0
TOTAL	100.0%	33.3%	66.7%

Of the 47% owning one car, more than half remain captive. Riders from two-car households are captive to a lesser extent (40%); but, surprisingly, even in two-or-more-car households, about 36% of transit riders from these households do not have an automobile available for the trips made by transit.

Highly significant is the fact that the best showing for preferential transit usage is among transbay riders. Nearly 80% of these own at least one automobile and about half of them have it available for their transbay trips. This latter figure demonstrates the capacity of fast and attractive transit service to attract commuters traveling considerable distances even when they have the option of using an automobile.

Car ownership and availabilty is an important consideration on use of local routes in the AC Transit system. About six out of 10 riders are from households owning one or more cars, but only two out of 10 have one available.

In the Muni system, as on the AC Transit system, about one-third of the riders are from zero-car households, while two-thirds do not have an automobile available for their transit trips. The percentages of captive riders within each automobile-ownership category are nearly identical with those discussed for AC Transit.

TRANSIT O-D SURVEY

Transit travel characteristics for the NCTDP study area were determined by a self-administered postage-free card survey conducted on all lines of Muni and AC Transit systems on typical weekdays in June, and on Greyhound commuter lines in August, 1965.[2] Interview cards were issued, by drivers, to each of the quarter-million fare-paying adult passengers traveling in the inbound direction. "Inbound" was toward the San Francisco Central Business District (CBD) on Muni routes and AC Transit transbay routes, and toward the Oakland CBD on AC Transit local routes. The fare collection system assured that only one card was issued to an adult passenger on each trip, regardless of the number of transfers made to complete the journey. In addition, this control was used to exclude child and student riders from the survey.

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[2] For a detailed explanation of survey procedures, see Simpson & Curtin, *Technical Memorandum No. 11: Characteristics of Bay Area Transit Riders in 1965*, September, 1965.

A total of 60,073 interview cards were issued to patrons by AC Transit operators on the 697 scheduled runs which comprise the weekday service on AC Transit's 52 local and transbay bus routes. Similarly, on the Muni system, vehicle operators issued 175,002 interview cards on the inbound legs of all 1,205 scheduled pull-out trains making up the regular weekday service on that system's 61 streetcar, bus and cable car lines.

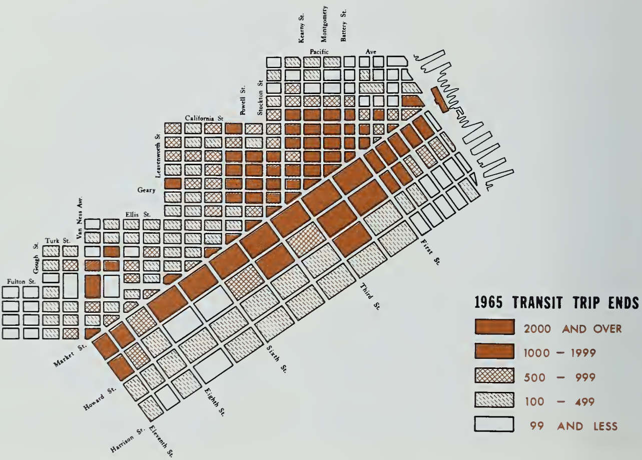
This survey of AC Transit and Muni riders was supplemented by coverage of three Greyhound suburban commuter divisions: Contra Costa, Richmond-Vallejo, and Peninsula (San Mateo County). A total of 11,111 cards was issued to adult riders as they boarded outbound Greyhound vehicles at central loading points in San Francisco and the East Bay Area.

Survey Method

Time, expense and required accuracy are the principal criteria in considering alternative survey methods. Where ample time and funds are available, the home interview is the most satisfactory survey approach. A complete list of questions can be asked of each respondent; accurate interpretation of questions is assured; and replies are entered in proper usable form in each instance, thus assuring a satisfactory quality of response. However, this approach also has drawbacks: months of interviewing are required to obtain an adequate sample, and it

FIGURE 8

DOWNTOWN DESTINATION OF MUNI PASSENGERS



involves high interviewing and data processing expenses. Furthermore, the sample size sufficient for auto use characteristics may be inadequate in measuring regional transit usage and statistically unsatisfactory for use in detailed feasibility analysis. In a recent nationwide poll of experts working in transit travel estimation conducted by a committee of the Highway Research Board, more than half of the respondents designated insufficient data from areawide transportation studies as a principal weakness in present transit analysis methods.

A home interview survey has been conducted by the Bay Area Transportation Study (BATS) in this same study area, as well as in adjoining counties. While the sample size—3% to 5% of housing units throughout the nine-county Bay Area—is adequate for BATS purposes, it is not sufficiently detailed for this study of current transit travel and future coordination.

Reliability of Data

Interview surveys are subject to error from two sources—those centering in the interview procedure and others due to variability arising from use of samples. The first of these was reduced to a tolerable minimum by incorporating systematic quality controls in the survey procedure; the second was regulated by steps to assure a sample of sufficient size to provide the desired level of accuracy.

The survey spanned the normal weekday service on each transit route, extending over periods of 16 to 22 hours for most of the Muni and AC Transit lines.

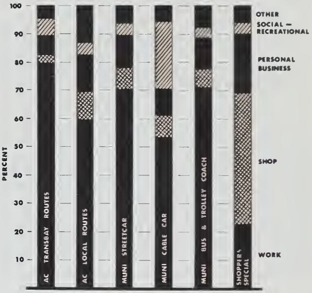
The overall survey return was 51% of cards distributed—an unusually high return for a self-administered survey, considering the number of questions involved, and substantially above the proportion needed to sustain a satisfactory level of reliability. The return for each system is summarized in the following tabulation.

	AC Transit	Muni	Greyhound	Total
Cards Issued	60,073	175,002	11,111	246,186
Cards Returned	36,163	82,963	6,500	125,626
Percent of Total Cards Issued	60.20%	47.41%	58.50%	51.03%
Cards Returned by Mail	12,055	49,075	3,952	65,082
Percent of Total Cards Returned	33.34%	59.15%	60.80%	51.81%

FIGURE 10

TRIP PURPOSE

OF BAY AREA TRANSIT RIDERS



Twelve items of information concerning each transit trip were developed from the interview card (Figure 11). Two-thirds of these come from questions requiring the rider's response; the others flow directly from preprinted information on the card. The completed card provided these twelve items of information:

a. Boarding stop on survey vehicle
b. Alighting stop on survey vehicle
c. Trip origin
d. Trip destination
e. Which trip-end is home, if any
f. Travel means to survey vehicle
g. Travel means from survey vehicle
h. Trip purpose
i. Auto ownership
j. Auto availability for tripmaking
k. Route of issuance
l. Time of issuance

Coding

The responses to the first four survey questions listed above were converted to machine language for computer analysis. To that end, two coding schemes were developed: one for the regular route stops in the AC Transit and Muni systems, applicable to the boarding stop and alighting stop replies, and another code system of travel analysis zones, applicable to the trip origin and destination queries.

Travel Analysis Zones—In delineating the analysis zones for origins and destinations of transit trips, the basic study area was first divided into four parts:

1. San Francisco CBD
2. San Francisco Remainder (outside CBD)
3. East Bay (Alameda and Contra Costa portions of the study area)
4. Northern San Mateo County

A total of 474 zones was developed, with an average population of 4,370 persons. Table 10 lists the number of travel analysis zones in each of the four divisions of the study area, along with the total population for each area and average population per zone. This arrangement resulted in a relatively even distribution of zone populations.

In the San Francisco CBD, where large volumes of trips are attracted to a relatively small area, city blocks were selected as the basic elements in defining zones. This also made the study compatible with similar undertakings by BATS and the San Francisco Downtown Parking Study, permitting an interchange of data. The blocks in the CBD were then grouped into 22 downtown zones, according to three criteria: (1) homogeneity of land use, (2) approximately equal land area, and (3) a maximum of one planned BARTD station in each zone.

In the remaining three divisions of the study area, travel analysis zones were made to conform as much as possible to census tract boundaries. These are small areas into which San Francisco and other large cities have been subdivided for statistical purposes by the U.S. Bureau of the Census.[3]

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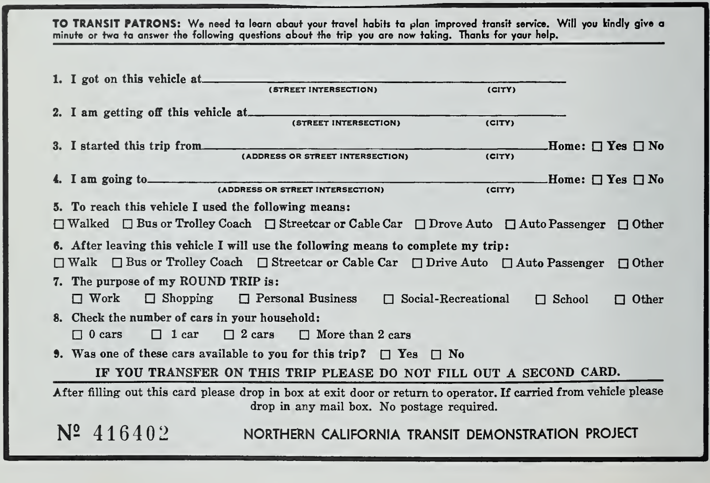
[3] Tract boundaries were established on the basis of uniform population characteristics, land use, economic status, living conditions and other socio-economic factors.

FIGURE 11
SURVEY POSTCARD



TO TRANSIT PATRONS: We need to learn about your travel habits to plan improved transit service. Will you kindly give a minute or two to answer the following questions about the trip you are now taking. Thanks for your help.

1. I got on this vehicle at ____________________ (STREET INTERSECTION) (CITY)

2. I am getting off this vehicle at ____________________ (STREET INTERSECTION) (CITY)

3. I started this trip from ____________________ (ADDRESS OR STREET INTERSECTION) (CITY) Home: ☐ Yes ☐ No

4. I am going to ____________________ (ADDRESS OR STREET INTERSECTION) (CITY) Home: ☐ Yes ☐ No

5. To reach this vehicle I used the following means:
☐ Walked ☐ Bus or Trolley Coach ☐ Streetcar or Cable Car ☐ Drove Auto ☐ Auto Passenger ☐ Other

6. After leaving this vehicle I will use the following means to complete my trip:
☐ Walk ☐ Bus or Trolley Coach ☐ Streetcar or Cable Car ☐ Drive Auto ☐ Auto Passenger ☐ Other

7. The purpose of my ROUND TRIP is:
☐ Work ☐ Shopping ☐ Personal Business ☐ Social-Recreational ☐ School ☐ Other

8. Check the number of cars in your household:
☐ 0 cars ☐ 1 car ☐ 2 cars ☐ More than 2 cars

9. Was one of these cars available to you for this trip? ☐ Yes ☐ No

IF YOU TRANSFER ON THIS TRIP PLEASE DO NOT FILL OUT A SECOND CARD.

After filling out this card please drop in box at exit door or return to operator. If carried from vehicle please drop in any mail box. No postage required.

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Table 10

POPULATION OF TRAVEL ANALYSIS ZONES

	Number of Travel Analysis Zones	1960 Population	Average Population per Zone
San Francisco CBD	22	50,592	2,300
San Francisco—Remainder	150	689,724	4,598
San Mateo County	29	153,800	5,303
East Bay	273	1,177,727	4,314
TOTAL	474	2,071,843	4,371

Much of the demographic data collected and published by the U.S. Bureau of the Census on a census tract basis pertains to important trip generation factors, e.g., population, income and household units. Care was taken, however, to insure that a zone did not take on a dominant trip-generation position resulting solely from its greater population; this would have distorted the importance of other trip generation factors. Since the tripmaker is the basic experimental unit in system testing, a normal distribution of population is desirable for various statistical tests such as analysis of variance. The average population of census tracts in the entire study area in 1960 was 4,818 persons; it was decided, therefore, to split—into two, three or more travel analysis zones—those tracts in which the population exceeded 10,000 persons.

Sample Selection—For some trip information, notably that relating to auto ownership and availability, the total number of returned survey cards was utilized. With respect to boarding and alighting stops as well as origin and destination zones, the card return was well in excess of that required for a uniform degree of reliability.

Statistical control of stratified random samples on each route to secure uniform confidence limits was incorporated in the trip factoring process, producing constant data reliability and also reducing the expense of coding and key punching. Out of 35,955 usable AC Transit interview cards returned, a final stratified random sample of 15,282 was selected for expansion to full trip volume. The overall sample of AC Transit riding amounted to 24.4%.

On the Muni system, a stratified sample of 36,189 cards was selected at random from the total of 81,805 usable Muni interview cards returned. This represents 17.8% of daily travel on Muni lines. The Muni sample is lower than that required on the AC Transit system since the higher volume of riding on Muni routes made possible the use of a smaller sample percentage to achieve the same degree of reliability.

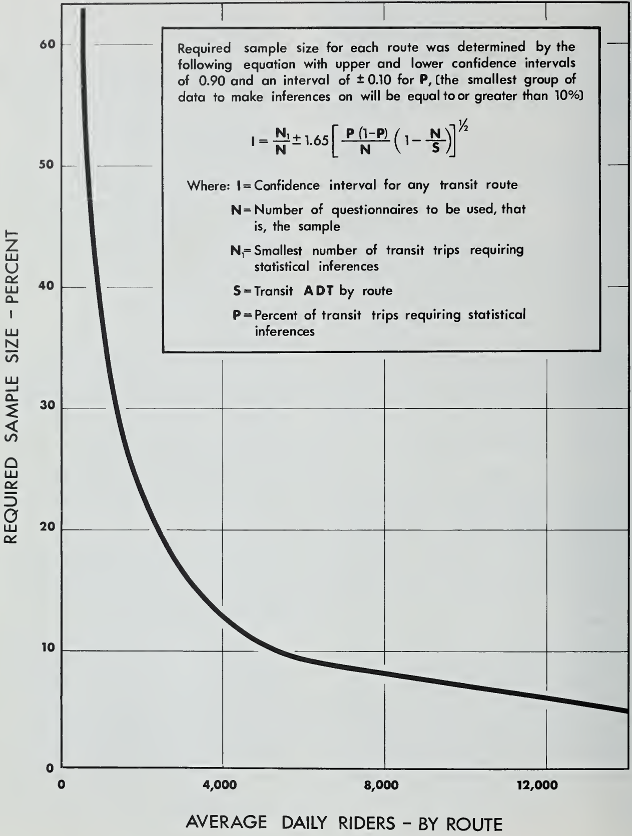
The method involved in the AC Transit and Muni sample selection assured that the data chosen were checked for randomness. Every transit rider had an equal chance of having his card selected. Investigation of bias was made on all the returned cards to determine that those cards were representative of all transit riders. This was accomplished through checks on census data and other known attributes of tripmakers from previous studies. The assumption of normality of the sample data is valid. Sample size was selected from known finite volumes of transit trips. When the total volume of transit trips is very great, such as occurred on several Muni and AC Transit routes, a reasonably large sample constitutes a very small percentage of the total, which, for practical purposes, can be considered infinite. When the same percent sample is taken from a small volume, the same degree of reliability is not obtained. Therefore, a curve was devised for the determination of sample size which would give the same statistical confidence interval for all route volumes and be consistent with cost and time considerations (Figure 12). That curve indicates the percent sample required for routes carrying various volumes of riders.

After sample selection, the cards for each route were factored to 1965 average daily traffic. Forty-six columns of information were keypunched, including all of the coded travel data and serial numbers.

This survey technique resulted in considerable time and cost savings over standard home interview procedures. Origin-destination trip tables were edited and available for analysis within 10 weeks of the survey date. Costs for the entire postcard survey (including all associated expenses through keypunching the coded data) averaged one dollar per card. Home interview studies reporting comparable data have resulted in average costs of $12 to $20 per interview.

FIGURE 12

REQUIRED SAMPLE SIZE



Required sample size for each route was determined by the following equation with upper and lower confidence intervals of 0.90 and an interval of ± 0.10 for **P**, (the smallest group of data to make inferences on will be equal to or greater than 10%)

$$I = \frac{N_1}{N} \pm 1.65 \left[\frac{P\,(1-P)}{N} \left(1 - \frac{N}{S} \right) \right]^{1/2}$$

Where: **I** = Confidence interval for any transit route

N = Number of questionnaires to be used, that is, the sample

N_1 = Smallest number of transit trips requiring statistical inferences

S = Transit **ADT** by route

P = Percent of transit trips requiring statistical inferences

REQUIRED SAMPLE SIZE - PERCENT
60
50
40
30
20
10
0
0
4,000
8,000
12,000
AVERAGE DAILY RIDERS - BY ROUTE

CHAPTER 3

Present Highway Travel

AUTO TRAVEL is by far the dominant means of transportation in the Bay Area and will continue in that role for the forseeable future. In the areawide picture, transit has a minimal, albeit critically important peak hour share of the total travel market. In assessing transit's future role in the Bay Area, it is necessary to define this total travel market not only in terms of transit use but also in terms of the use and supply of highway facilities.

Origin-destination information for use in this analysis was developed from data obtained from the California Division of Highways and is derived from information currently used for the planning of the Bay Area System of Interstate Highways. Vehicular trip ends for each of the 474 NCTDP study area zones were subdivided and updated utilizing these Highway Division data. Trip distribution computer programs in use by the Highway Division were utilized in conjunction with a 1965 Bay Area highway network as provided by the Highway Division and coded by the NCTDP staff. Trips were distributed through the Division's 704 gravity model program and the resulting distribution and "minimum path" travel times supplied to the Project.

Trips between major sectors of the study area have been checked against ground counts and the 1965 cordon count to establish the accuracy of the vehicular origin-destination data for use in subsequent analysis. The 1965 highway network coded by the Project staff utilized travel facilities defined by the Highway Division including the complete system of 1965 freeways, expressways and major arterial streets. Travel speeds on these facilities as well as local collector streets connecting zone centroids were also provided by the California Division of Highways.

Bay Area Travel Facilities

The highway network serving Bay Area communities, like the transit network, is signally limited by the severe topographic barriers including, of course, San Francisco Bay and the mountainous sections throughout the Bay Area.

Figure 13 depicts the major Bay Area crossings along with the system of freeways and major arterial highways serving San Francisco and East Bay communities. Traffic volumes for the average weekday in 1964 are also shown.

In all, eight bridges span the Bay or arms of the Bay. The most noteworthy and busiest is the San Francisco-Oakland Bay Bridge. This structure, originally built for auto traffic and trains, has been reconstructed with an upper deck of five lanes for westbound traffic and a lower deck accommodating the corresponding eastbound movement. As indicated in Figure 13, the bridge carried 127,000 vehicles over both of its 58′ cartways.

Another world-famed crossing is the Golden Gate Bridge. This facility, connecting San Francisco with communities to the north in Marin County, carries 67,000 vehicles a day on its 60′ roadway.

Table 11

PERSONS ENTERING AND LEAVING DOWNTOWN SAN FRANCISCO

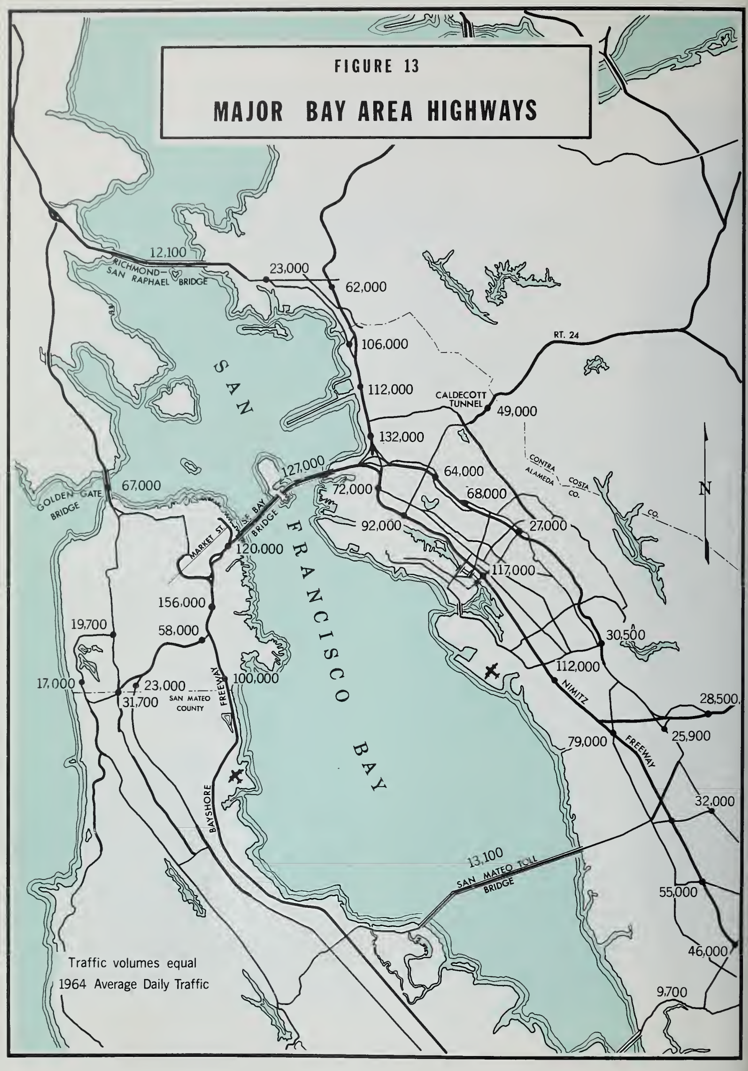
Weekday—10 A.M. to 6 P.M.

	Auto and Taxi	Mass Transit	Total	Percent Mass Transit
1947	354,273	312,705	666,978	47.0%
Percent Change	+68.5%	—31.1%	+21.8%	
1959	596,815	215,553	812,368	26.5%
Percent Change	+8.6%	+12.4%	+9.6%	
1965	648,070	242,229	890,299	27.2%

SOURCE: 1965 Downtown Parking and Traffic Survey.

FIGURE 13

MAJOR BAY AREA HIGHWAYS



Traffic volumes equal 1964 Average Daily Traffic

Figure 13 further highlights traffic volumes on other major Bay Area traffic facilities. The maximum traffic volume shown is 156,000 vehicles per day on the James Lick Freeway in the vicinity of the Army Street Interchange. This volume, as the Freeway approaches the San Francisco CBD, is composed of traffic from the San Mateo Peninsula on both the Bayshore and Southern Freeways. The Bayshore Freeway contributes approximately twice as much volume as the Southern Freeway. In total, the major routes across the southern section of San Francisco contribute approximately 172,000 vehicles per day entering and leaving the city.

Substantial volumes are also in evidence on highway facilities in the East Bay section of the Bay Area. Freeway volumes ranging as high as 132,000 vehicles per day are illustrated on Figure. 13.

Downtown San Francisco Cordon Count

Muni vehicles carry 121,000 persons to and through downtown San Francisco between 10 A.M. and 6 P.M. on an average weekday. This tally of transit riders entering and leaving the CBD was made by Muni traffic checkers on typical weekdays in August 1965. The counts were taken at 32 points of entry and exit around the CBD.

Maximum accumulation of transit patrons downtown occurs between 1:30 and 2:00 in the afternoon. The excess of workers and shoppers in the area is nearly 58,000 more than those who have returned home by that time of day.

Concurrent with the transit cordon count, a similar check on automobiles and pedestrians entering the CBD was made by the San Francisco Downtown Parking and Traffic study. These data provide a complete picture of person-trips in and out of the downtown area. Cordon count stations were designed to match similar data collected in 1947 and 1959.

While persons entering by auto and taxi have increased significantly in each successive survey period, mass transit is regaining a share of the passengers lost between 1947 and 1959 (Table 11). Dropping from abnormally high wartime levels in 1947, mass transit leveled out in 1959 with a total of 215,553 trips entering and leaving the CBD between the hours of 10 A.M. and 6 P.M. In the intervening six years to 1965, this figure increased 12.4% to a total of 242,229 mass transit person trips.

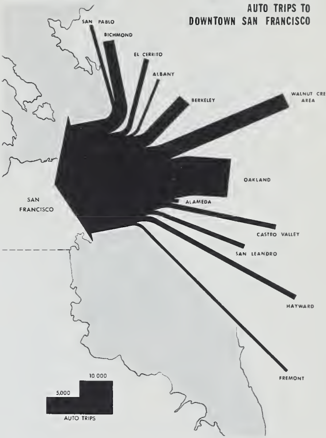


FIGURE 14

ORIGINS OF TRANSBAY AUTO TRIPS TO DOWNTOWN SAN FRANCISCO

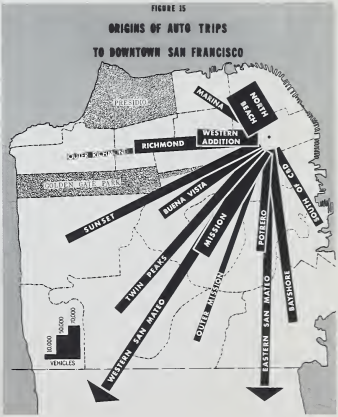
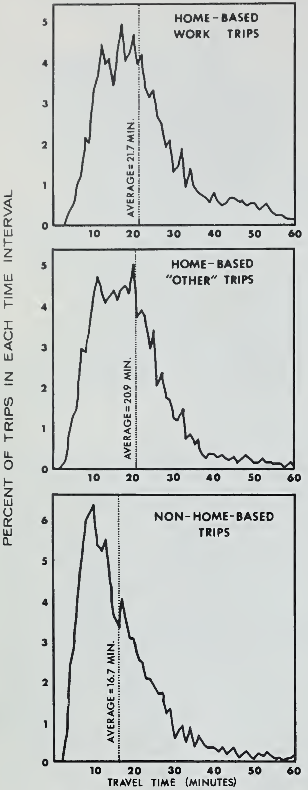


FIGURE 15

ORIGINS OF AUTO TRIPS TO DOWNTOWN SAN FRANCISCO

FIGURE 16

TRANSIT TRIP LENGTH FREQUENCY DISTRIBUTIONS



NOTE: TRAVEL TIME FOR EACH TRIP IS "PORTAL TO PORTAL" AND INCLUDES ACCESS TO BUS ROUTES, LINE HAUL AND TRANSFER TIME.

In the critical evening peak period between 4:30 and 5:30 P.M., mass transit carries almost half the total persons, although it represents only 2.1% of the vehicles on the street. This is a measure of the significance of mass transit to the congested downtown area (Table 12).

It is noteworthy that while vehicular trips increased 8.6% in the period between 1959 and 1965 during the hours of 10 A.M. to 6 P.M. (from 597,000 to 648,000), there was a 2.4% *decrease* in vehicular trips leaving the CBD during the evening peak period (from 71,000 to 69,000). Downtown congestion has actually caused a spreading of the automobile peak so that even though more autos are in use to and through the CBD, fewer are able to leave during the critical peak hour.

Table 12

PERSONS LEAVING DOWNTOWN SAN FRANCISCO

Weekday—4:30 to 5:30 P.M.

	Auto and Taxi	Mass Transit	Total	Percent Mass Transit
1947	47,585	68,251	115,836	59.0%
Percent Change	+49.6%	—18.4%	+9.5%	
1959	71,190	55,671	126,861	44.0%
Percent Change	—2.4%	+5.1%	+0.9%	
1965	69,471	58,537	128,008	45.7%

SOURCE: 1965 Downtown Parking and Traffic Survey.

East Bay Trips Destined to Downtown San Francisco

The San Francisco CBD does not hold the same significance for East Bay vehicular trips as it does for transit; only 18.5% of vehicular trips are to the San Francisco CBD, while 58.6% of transit trip attractions are in the San Francisco CBD. Nevertheless, it remains the area of maximum interest for determining the potential market divertible to future transit improvements.

The four principal East Bay cities—Oakland, Berkeley, Richmond and Alameda—produce almost two-thirds of the total transbay trips destined for San Francisco CBD (Figure 14). These four cities generate 20,900 vehicular trips or approximately 31,360 person-trips per day. Oakland is the largest single producer of transbay vehicular trips to the San Francisco CBD, with 34.8% of the total.

Transbay vehicular trips destined to the San Francisco CBD amount to 33,570 daily. This represents approximately 36% of the 94,400 transbay trips beginning or ending in the NCTDP study area (external trips to points outside of the study area have been eliminated from this analysis). From the transit survey, approximately 65% of transit transbay trips were CBD-bound, as opposed to this 36% of auto tripmakers.

Major Desire Lines to Downtown San Francisco

Major corridors for movements terminating in downtown San Francisco account for a total of 353,180 vehicular trips daily (Figure 15).

The biggest producer of auto travel is the densely developed North Beach area with 70,600 trips. The aggregate volume from the Richmond section (the total for Western Addition, Richmond and Outer Richmond) is second with 68,600 trips or 19.4% of the total CBD-destined trips. The corridor which is third in significance is the Mission area, including the desire lines labelled Mission, Outer Mission and San Mateo West. The aggregate from the Mission area is 67,100 trips, or 19% of total CBD destinations, and amounts to 101,000 persons daily. This represents potential BARTD traffic, since the rapid transit line will split this corridor.

Travel Time on Present Transit Routes

The distribution of transit trips by total elapsed travel time was determined between each pair of zone-to-zone movements for three trip purposes, along with the average trip length for each category (Figure 16). There is a significant difference between purposes—work trips, as may be expected, are the longest of any trip type, averaging 21.7 minutes for the entire study area. Non-home-based trips which are usually more closely related to the density and convenience of transit service provided have a short average trip length of only 16.7 minutes. The non-home-based trip distribution is also much more peaked than the others, with 50% of the non-home-based trips being less than 14 minutes.

Travel Time—Auto vs. Transit

A principal determinant of transit's attractiveness is the comparison of travel times with auto travel. Comparison of trip length frequency

FIGURE 17

TRIP LENGTH FREQUENCY DISTRIBUTIONS
TRANSIT VS. AUTO

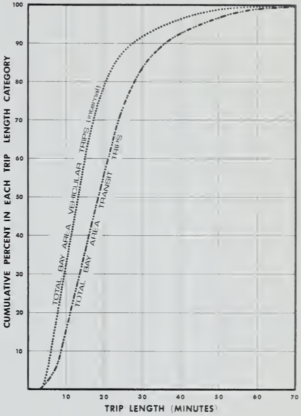
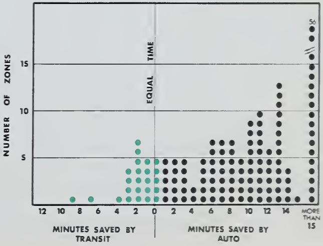


FIGURE 18

COMPARATIVE TRAVEL TIME
TO DOWNTOWN SAN FRANCISCO

172 SAN FRANCISCO ZONES



distributions for both total Bay Area vehicular trips and transit trips over the 1965 network indicates the cumulative percentage of trips occurring in each travel time increment (Figure 17). It is interesting that the 50th percentile for transit trips occurs at an average trip length of 18.5 minutes while the 50th percentile for auto trips is significantly lower at 13 minutes. The median transit trip is 42% longer than the median auto trip.

Travel time ratios, i.e., travel time via the transit system divided by the time via the highway system, have been calculated for each pair of zones. An analysis of these for trips to the financial center (Montgomery and California Streets) of the San Francisco CBD indicates ratios ranging from 0.5 to 3.5. In other words, there are some zones where transit is twice as fast as the automobile and others where the automobile is 3½ times as fast as transit.

Figure 18 illustrates the respective time advantages of transit and the automobile to the financial center of downtown San Francisco. This chart shows the travel time differential for each of the 172 San Francisco zones as they relate to the CBD. To the left of the "equal time" line, there are 19 zones in which transit has a time advantage over the automobile in reaching the CBD. Aggregating those from which transit time is equal to or less than auto travel time, transit now holds its own or is faster than autos from 15% of the total 172 San Francisco zones.

More significantly, Figure 18 points up the fact that with only a five-minute improvement in overall transit service, the number of zones in which transit would have a time advantage over the automobile can be doubled, bringing 30% of San Francisco zones into an area of transit travel time advantage.

The extreme right side of Figure 18 illustrates those zones where auto travel has a distinct time advantage—more than 15 minutes. This category accounts for approximately one-third of the San Francisco zones and is made up of areas where any transit improvement is unlikely to overcome the advantages of the automobile. In the section between the five-minute auto advantage and the 15-minute auto advantage, there lies the remaining third of San Francisco zones where significant improvements in the quality of transit service offered could conceivably overcome some of the travel time advantage offered by the auto.

On the East Bay side, the advantage of transit to the San Francisco CBD is not quite as great; only 9% of the 270 East Bay zones have transit times which are equal to or better than corresponding automobile time.

Table 13

MUNI PATRONAGE AND SERVICE
BY TYPE OF VEHICLE
Year Ended June 30, 1965

Type of Vehicle	Passenger Revenue	Revenue Passengers	Total Passengers	Miles Operated	Hours Operated	Average Speed (m.p.h.)	Revenue per Mile	Revenue per Hour	Total Passengers Per Mile
Streetcar (3 routes)	$ 2,963,214 (15.1%)	21,431,321 (15.1%)	28,164,302 (13.9%)	3,476,384 (13.2%)	344,622 (12.3%)	10.09 (107.5%)	85.24¢ (114.6%)	$8.60 (123.0%)	8.10 (105.7%)
Cable Car (2 routes)	1,152,676 (5.9%)	8,229,442 (5.9%)	9,750,170 (4.8%)	421,607 (1.6%)	90,622 (3.2%)	4.65 (49.5%)	273.40¢ (367.6%)	12.72 (182.0%)	23.13 (302.0%)
Trolley Coach (11 routes)	6,867,311 (35.0%)	49,657,894 (35.0%)	72,789,182 (36.0%)	8,092,462 (30.7%)	967,352 (34.4%)	8.37 (89.1%)	84.86¢ (114.1%)	7.10 (101.6%)	8.99 (117.4%)
Bus (37 routes)	8,645,962 (44.0%)	62,406,251 (44.0%)	91,340,339 (45.2%)	14,398,371 (54.6%)	1,406,437 (50.1%)	10.24 (109.1%)	60.05¢ (80.7%)	6.15 (88.0%)	6.34 (82.8%)
TOTAL	$19,629,163	141,724,908	202,043,993	26,388,824	2,809,033	9.39	74.38¢	$6.99	7.66

Note: Figures in parentheses represent the percentage relationship of the value shown for each type of service to the system total.

CHAPTER 4

Existing Transit Service

MUNI SERVES the City of San Francisco with a network of 61 surface transit lines[1] divided among four vehicle types—cable cars, streetcars, trolley coaches and motor buses. With a few minor exceptions, service is operated entirely within the City of San Francisco.

AC Transit's 65 routes[2] are all operated with motor coaches. The subdivision of this system is functional: 16 routes comprise regional trans-bay bus service to San Francisco, while the remaining 49 lines provide local and express service among East Bay communities.

Muni Patronage and Service

Muni operated more than 26 million miles in 1965[3] over its 37 bus lines, 11 trolley coach routes and five streetcar and cable car lines (see Figure 19).

While buses operated 70% of the routes, they accounted for only 55% of the mileage operated and 44% of the passenger revenue collected (Table 13). At the other extreme, the cable car lines operated only 1.6% of the total miles provided on the system but accounted for nearly 6% of the passenger revenue collected. The resulting productivity found buses yielding 60¢ in passenger revenue for each mile of operation as compared to revenue of $2.73 for each cable car mile of service provided. The street car and trolley coach routes produced approximately 85¢ per mile.

The advantage of the cable car lines over other classes of service is very much less when the productivity is compared in terms of hours of service. Bus lines operate at slightly more than 10 miles per hour while the cable cars average less than 5 miles per hour. Thus, revenue per hour on the buses aggregated $6.15 in fiscal 1965, as compared with $12.72 on the cable car lines, $8.60 on the streetcar operation and $7.10 per hour on the trolley coach lines.

Classification of Patronage by Type of Route

The 53 Muni route combinations have been classified into three broad categories: arterial routes which serve the Central Business District; crosstown lines which connect a number of arterials; and feeder lines which bring passengers to the arterials, or shuttle service. Nearly two-thirds of the Muni lines are arterials which bring people into downtown San Francisco. Thirty-four of the 53 route combinations fall into this category, as opposed to seven routes which are classfied as crosstown operations, and 12 lines which are feeder or shuttle services (Table 14).

The degree to which the Muni system is dominated by major trunk lines is evidenced by the fact that the 34 arterials account for 82.5% of the mileage operated on the entire system and produce 87.6% of the aggregate passenger revenue (Table 14)—only about one in eight of Muni's riders use crosstown or feeder lines.

The revenue per mile on the arterials is 79¢ as compared with 54¢ per mile on the crosstown lines and less than 35¢ per mile on the feeder and shuttle routes. Revenue per hour on the arterial lines aggregated $7.45 as compared with $5.05 on the crosstowns and $3.21 on the feeders.[4]

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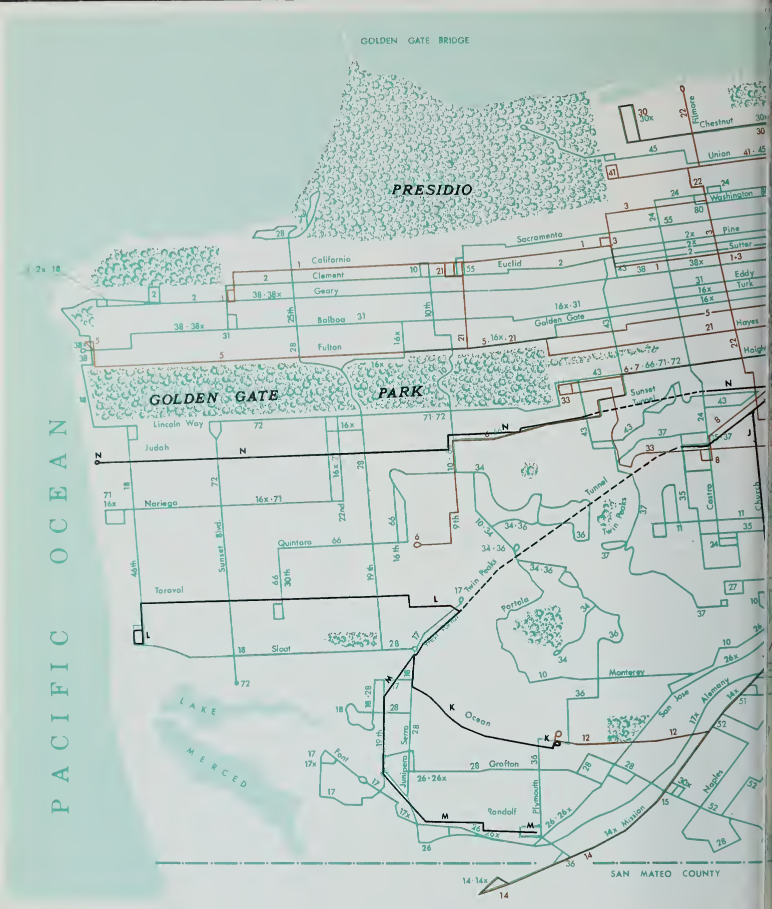
[1] The 61 operational routes are combined into 53 routes for accounting purposes.

[2] AC Transit's 65 operational routes are combined into 52 routes for accounting purposes.

[3] The base period used in passenger, revenue and cost analyses in this study is the fiscal year ended June 30, 1965.

[4] By their nature, feeder routes carry a higher proportion of transfer passengers and get credit for revenue in one direction only, in accordance with normal transit practice.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GOLDEN GATE
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LAKE MERCED
SAN MATEO COUNTY
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Washington
Pine
Sutter
Eddy
Turk
Hayes
Haight
Fillmore
Sacramento
Euclid
California
Clement
Geary
Balboa
Fulton
Golden Gate
Lincoln Way
Judah
Noriega
Quintara
Toraval
Sloat
Sunset Blvd.
46th
25th
10th
9th
16th
19th
22nd
30th
Sunset Tunnel
Tunnel
Twin Peaks
17 Twin Peaks
Portola
West Portal
Ocean
Monterey
San Jose
Alemany
Mission
Naples
Castro
Church
Grafton
Rondolf
Plymouth
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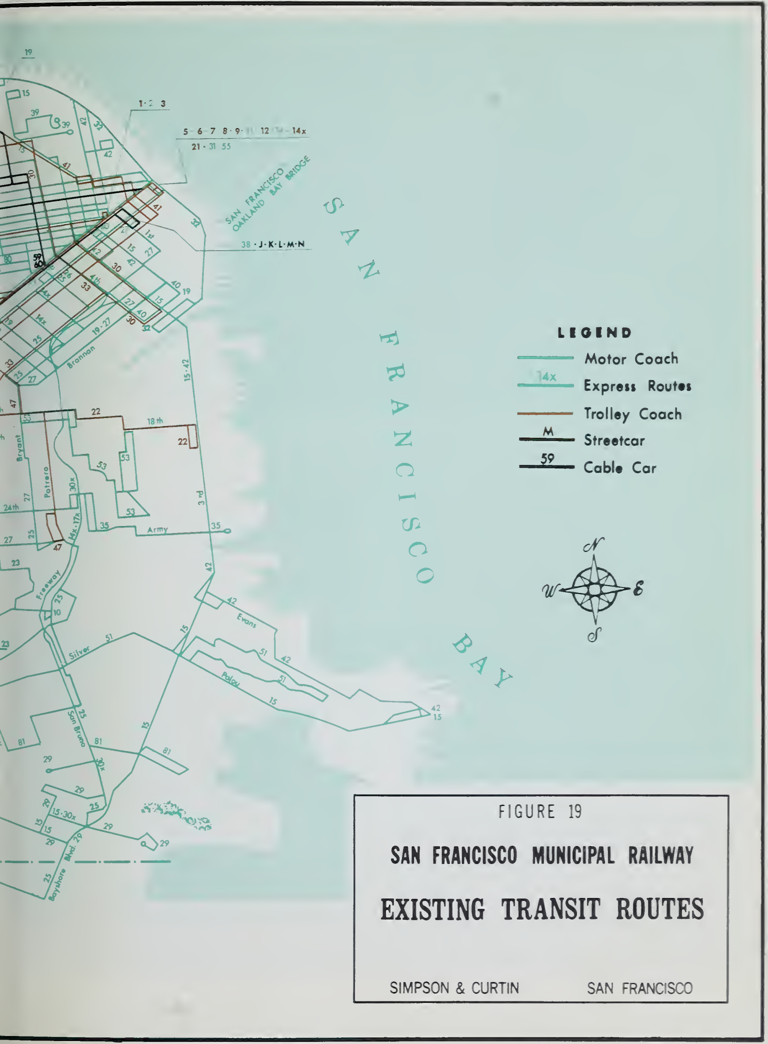

FIGURE 19

SAN FRANCISCO MUNICIPAL RAILWAY

EXISTING TRANSIT ROUTES

SIMPSON & CURTIN SAN FRANCISCO

Table 14

MUNI PATRONAGE AND SERVICE
BY TYPE OF ROUTE
Year Ended June 30, 1965

Type of Route	Passenger Revenue	Revenue Passengers	Total Passengers	Miles Operated	Hours Operated	Average Speed (m.p.h.)	Revenue per Mile	Revenue per Hour	Total Passengers per Mile
Arterial	$17,192,415	124,241,188	174,681,674	21,776,778	2,308,134	9.44	78.95¢	$7.45	8.02
(34 routes)	(87.6%)	(87.7%)	(86.5%)	(82.5%)	(82.2%)	(100.5%)	(106.1%)	(106.6%)	(104.7%)
Crosstown	1,751,755	12,615,534	20,704,100	3,215,999	347,031	9.28	54.47¢	5.05	6.44
(7 routes)	(8.9%)	(8.9%)	(10.2%)	(12.2%)	(12.4%)	(98.8%)	(73.2%)	(72.2%)	(84.1%)
Feeder or Shuttle	360,523	3,523,424	5,248,797	1,043,877	112,201	9.30	34.54¢	3.21	5.03
(12 routes)	(1.8%)	(2.5%)	(2.6%)	(4.0%)	(4.0%)	(99.0%)	(46.4%)	(45.9%)	(65.7%)
Other Service	324,470	1,344,762	1,409,422	352,170	41,667	8.45	92.13¢	7.79	4.00
(Charter, Baseball & Cable Emergency)	(1.7%)	(0.9%)	(0.7%)	(1.3%)	(1.5%)	(90.0%)	(123.9%)	(111.4%)	(52.2%)
TOTAL	$19,629,163	141,724,908	202,043,993	26,388,824	2,809,033	9.39	74.38¢	$6.99	7.66

Note: Figures in parentheses represent the percentage relationship of the value shown for each type of route to the system total.

The 10 largest arterial routes carry more than half of the aggregate passengers on the Muni system. The four largest arterials—the Mission trolley coach lines, the Twin Peaks streetcar lines, and the Geary and the Third-Evans bus routes—account for 27½ percent of the total passengers carried on the system. Among the 25 heaviest lines, only one—the Fillmore crosstown trolley coach route—does not serve downtown as an arterial line. Generally speaking, the crosstown routes are comparable to the lesser arterial lines in their aggregate patronage, and the bus feeder lines bring up the rear—far less productive than other routes.[5]

When the routes are examined in terms of total passengers carried per vehicle mile of operation, the arterial lines are found to dominate the picture in overwhelming fashion. As already noted, the two cable car lines are the most productive on the system in terms of passengers carried per mile of operation. Compared with the system as a whole, the cable cars carried 2½ to 3 times the patronage per unit of service. With only two exceptions, all of the routes which have passenger productivity exceeding the system average by 10 percent or more are arterial lines. A total of 21 lines equals or exceeds the system average in terms of passengers per mile: 18 of these 21 are arterial routes.

Another approach to the comparison of route productivity is the passenger revenue produced per hour of service. This measure takes into account the variations in speed among the routes. Once more, the cable car lines head the list, producing revenue per hour in the range of $12 to $13. The 24 highest-ranking lines in terms of revenue productivity are arterials. Crosstown lines produce revenue per hour comparable to the less productive arterials, while the bus feeder lines are far less productive than other classes of service.

Trend of Muni Patronage—1960 to 1965

Some guide to future traffic levels is available through analysis of the trend of patronage, service and productivity of all Muni routes since 1960. The general picture which emerges from this analysis is one of unusual stability in the several categories of routes (Table 15). No significant change in the level of service has occurred on the arterial or crosstown routes, and only a minor increase in service has been effected on the feeder or shuttle operations.

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[5] Simpson & Curtin, *Technical Memorandum No. 41: Revenue and Cost Analysis*, January, 1966.

There was a slight decline both in miles and hours of operation during the period 1960 to 1965 on the major arterials (down 1.4 percent in miles and 1.7 percent in hours). Revenue passengers and total passengers changed less than 1 percent over the same five years on the arterial routes. Average speed was virtually unchanged. Hence, the various measures of productivity—revenue per mile, revenue per hour, and total passengers per mile—revealed no significant change.

The same general conclusion applies to the seven crosstown lines where the reduction in mileage and hours of service was slightly greater (miles down 1.9 percent and hours down 3.5 percent). Once again, the productivity figures per unit of service showed no meaningful change over the period.

On the feeder and shuttle lines, there was an increase both in miles and hours since 1960, but the magnitude of change is small (miles up 1.9% and hours increased 4.8%). Revenue passengers and total passengers on the feeder or shuttle lines have increased between seven and eight percent, with a resulting increase in revenue per mile, revenue per hour, and total passengers per mile, in the range of 4% to 7% over the five-year span.

The degree of stability on the regular route operations of Muni in recent years is evidenced by the fact that each of the nine measures of patronage, service and productivity included on Table 15 varied less than 2 percent between 1960 and 1965. Meanwhile, in the years 1960 to 1965, transit industry data for all surface operations in the country reveal a mileage reduction of 7.9 percent, a passenger decline of 15.2 percent and a decrease in passengers per mile of 8.1 percent.[6]

AC Transit Patronage and Service

AC Transit operated 22.7 million miles over 52 bus routes in 1965 (Table 16).[7] Twelve of these routes operated between the East Bay and downtown San Francisco, 18 were arterial lines in East Bay operation, three have been classified as crosstown routes and the remaining 19 lines were feeder operations (Figures 20, and 21).

In terms of volume of service, the 12 transbay lines accounted for nearly one-third of the aggregate vehicle miles operated, while the 18 East Bay arterials provided one-half of the system mileage, leaving some 17% of the system miles for the crosstown and feeder lines.

Table 15

TREND OF MUNI PATRONAGE AND SERVICE
BY TYPE OF ROUTE
1960 to 1965

	Percent Change From 1960 to 1965 (Years Ended June 30)								
Type of Route	Passenger Revenue	Revenue Passengers	Total Passengers	Miles Operated	Hours Operated	Average Speed	Revenue per Mile	Revenue per Hour	Total Passengers per Mile
Arterial (34 routes)	-1.35%	-0.80%	+0.83%	-1.37%	-1.67%	+0.32%	+0.03%	+0.40%	+2.56%
Crosstown (7 routes)	-2.48	-1.88	-2.18	-1.90	-3.53	+1.87	-0.60	+1.20	-1.54
Feeder or Shuttle (12 routes)	+8.85	+7.44	+7.97	+1.89	+4.83	+2.82	+6.84	+3.88	+6.38
TOTAL	-1.28%	-0.71%	+0.68%	-1.31%	-1.66%	+0.32%	+0.03%	+0.43%	+1.32%

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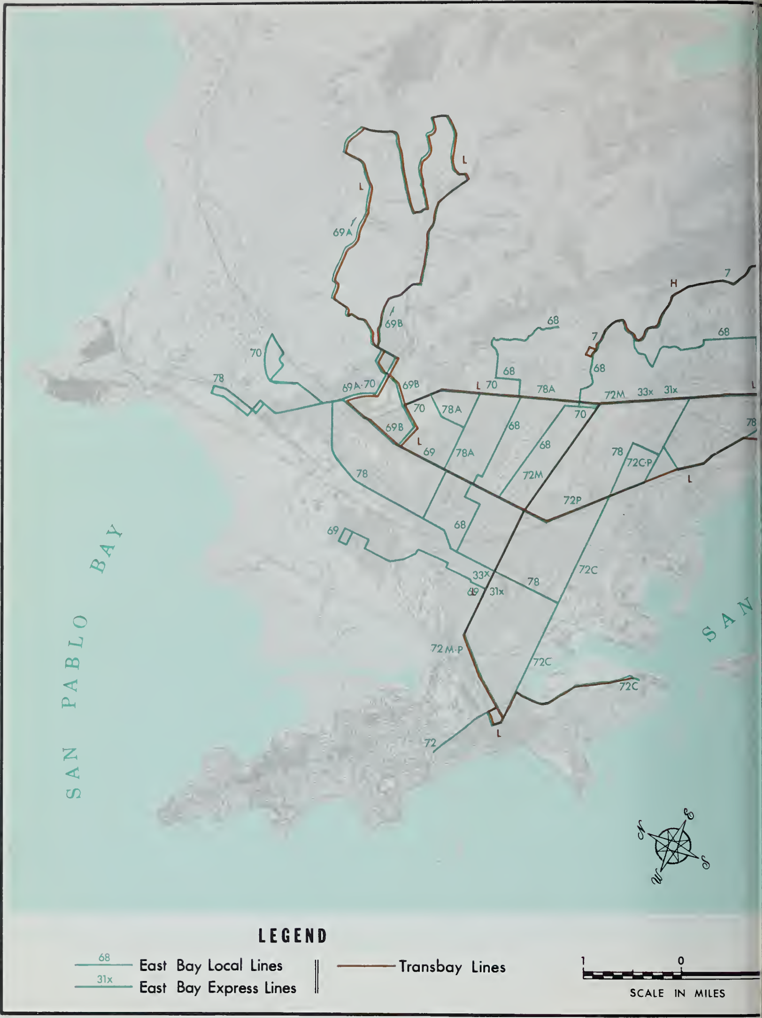
[6] While the individual route data do not reflect the same degree of stability as the totals by category of route, they do indicate that in the substantial majority of instances, the range of patronage change in the last five years has been less than 10 percent (Technical Memorandum No. 41).

[7] The base period used in passenger, revenue and cost analyses in this study is the fiscal year ended June 30, 1965.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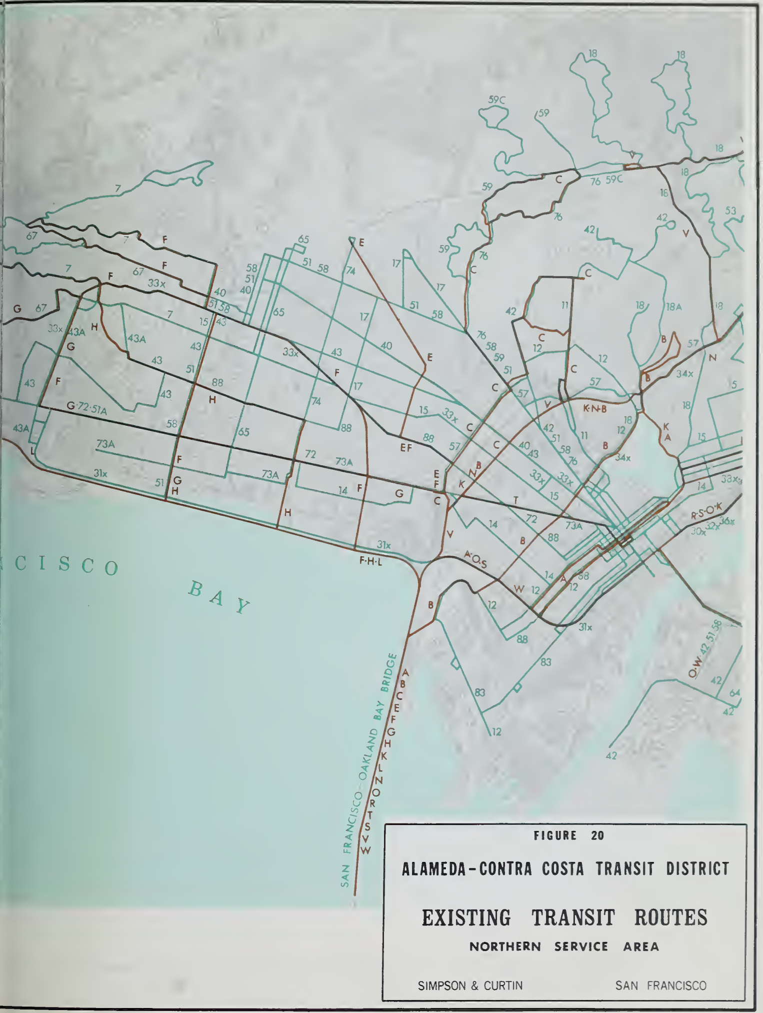


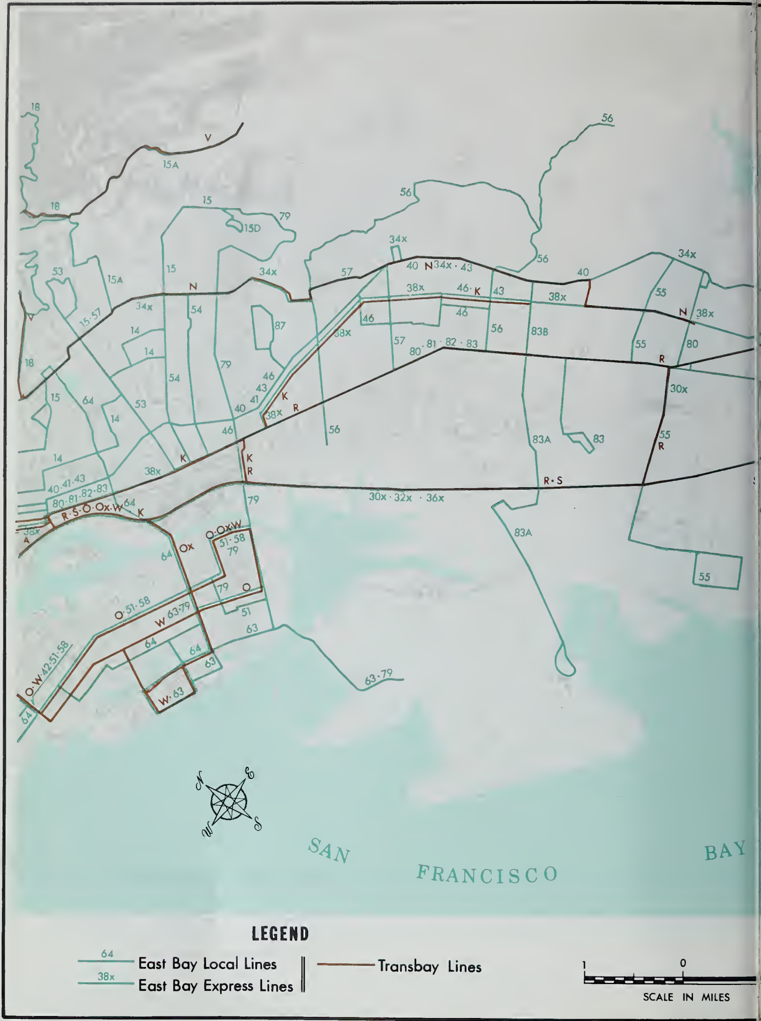
FIGURE 20

ALAMEDA-CONTRA COSTA TRANSIT DISTRICT

EXISTING TRANSIT ROUTES

NORTHERN SERVICE AREA

SIMPSON & CURTIN SAN FRANCISCO


SAN FRANCISCO BAY
LEGEND
64 East Bay Local Lines
38x East Bay Express Lines
Transbay Lines
1 0
SCALE IN MILES
N E S W
V
15A
18
15
15D
79
56
34x
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40 N 34x · 43
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87
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80 · 81 · 82 · 83
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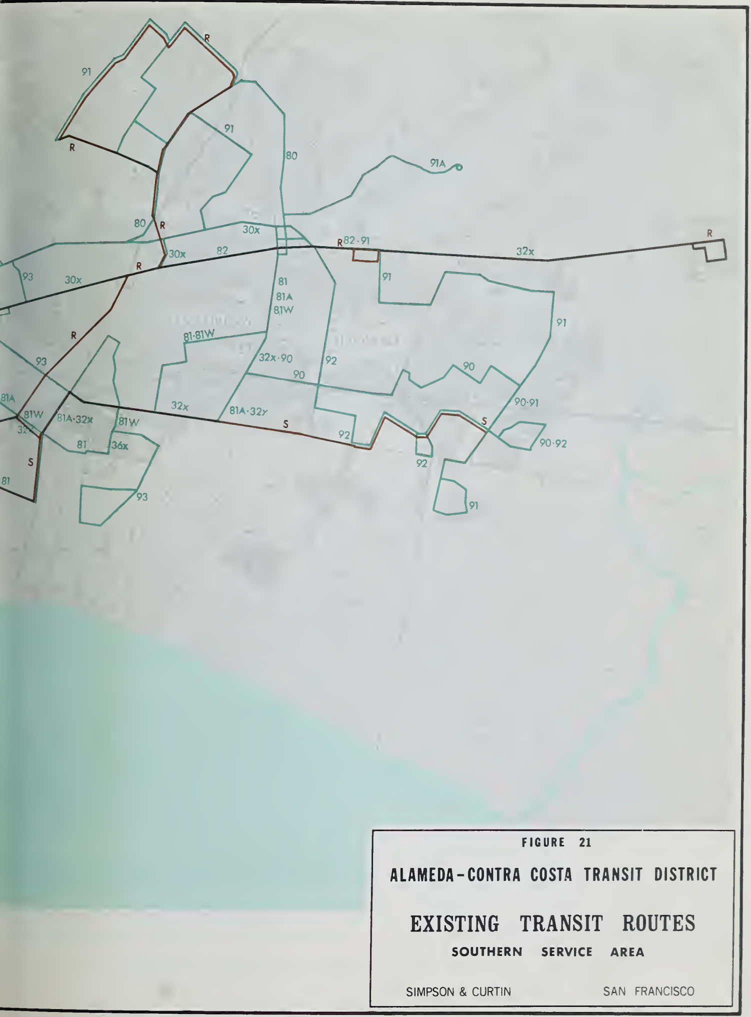

FIGURE 21

ALAMEDA-CONTRA COSTA TRANSIT DISTRICT

EXISTING TRANSIT ROUTES

SOUTHERN SERVICE AREA

SIMPSON & CURTIN SAN FRANCISCO

over 1961 on transbay lines and up 3.5% on the feeder lines over the same period. Since both of these categories of routes have experienced an increase in speed since 1961, the revenue productivity per hour rose even more. The gain per hour was 9.7% on the transbay lines and 9.1% on the feeder routes.

On the local East Bay arterial and crosstown lines, the gain in passengers and revenue was less than the increase in service, with the result that revenue per hour was down slightly (−0.3%) on the arterial lines and by a somewhat larger amount (−5.6%) on the crosstown routes.

An analysis of revenue passenger trends on individual routes over the past five years reveals some divergent trends among individual lines and points up the particular areas of growth as against those which are relatively stable.[10]

Muni Operating and Plant Facilities[11]

The present Muni facilities are the result of gradual absorption and accumulation of numerous private and municipal endeavors in the transit history dating back to the 1870's. The last major improvement program was conducted in 1950 principally for motor coach facilities.

1. *Rolling Stock* consists of 1,028 revenue vehicles and 96 service cars and trucks. The adequacy of revenue and non-revenue vehicles, as determined by evaluation techniques based on condition, age and mileage, is summarized in the following items.
    - The fleet of 75 White gasoline powered buses (1939-1948) is outmoded, in poor condition, beyond reasonable longevity, and overdue for replacement.
    - Diesel coaches consisting of a fleet of 449 Mack buses (1955-1960) require a high rate of maintenance, sustain high damage from street and yard congestion, and could achieve three to eight years more service. This, however, is considered generous from condition of the fleet.
    - Trolley coach operating units (360 Marmon-Harrington, Twin Coach, and St. Louis Car Co. 1948-1952) have been found to be well maintained, in good condition, and upgraded by recent motor reconditioning program, which is expected to extend remaining life six years.
    - Streetcars, consisting of 105 PCC type units (St. Louis Car Co. 1946-1952), were found to be well maintained, in good condition, with remaining life of 10 to 16 years.
    - The cable car fleet, unique to operating transit properties, consists of 39 units (1893-1904) maintained in good condition and expected to last indefinitely.
    - Five rail service vehicles, 31 automobiles for supervisory personnel and 60 service trucks, comprise the non-revenue fleet. Rail units, while antiquated, are functional, in good condition, and adequate for present operation. Automotive equipment, generally models 1950-1965, is replaced regularly and not retained beyond useful life.
2. *Way and Structures.* This property consists of two sections of streetcar right-of-way; the use of two city-owned tunnels, Twin Peaks and Sunset; 44.08 miles of streetcar trackage; 9.94 miles of trackage for cable car operation; two passenger stations in Twin Peaks Tunnel; four streetcar terminals; and 21 waiting shelters. The facilities generally are adequate for present functions, but all are in need of reconditioning and renovation, principally the streetcar trackage and Forest Hill Station underground section.
3. *Shops and Garages.* Maintenance of vehicles is provided by facilities at six operating divisions (two for motor coaches, two for trolley coaches, one for streetcars and one for cable cars), one electrical equipment overhaul shop, one automotive overhaul shop, and one paint shop. Mechanical cleaning and washing systems are provided for service of coach equipment. Machine shop and repair equipment is provided for overhaul of all types of

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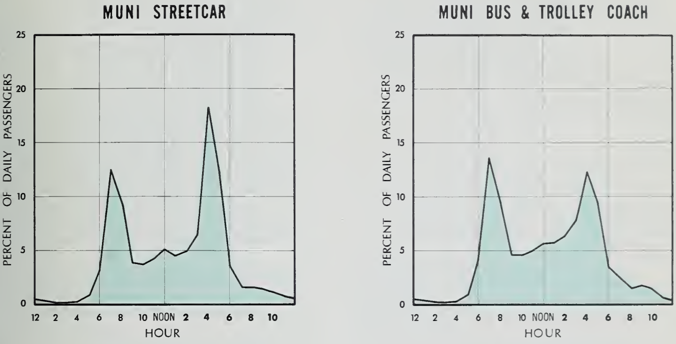
[10] *Ibid.*

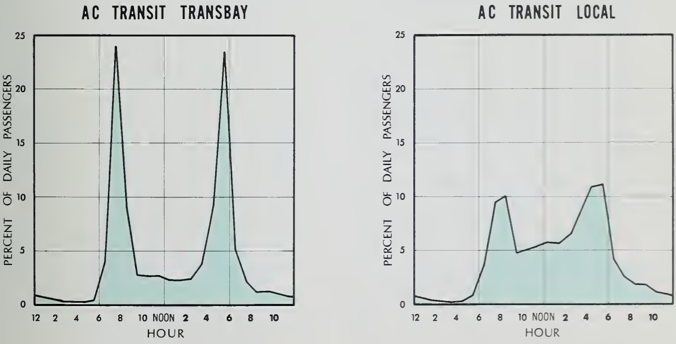
[11] This section presents the principal findings from a detailed inventory and evaluation of Muni physical facilities prepared by Kaiser Engineers and FMC Corporation to complete requirements of NCTDP Work Item No. II (Kaiser Engineers, *Final Report: Inventory, Evaluation and System Planning for the San Francisco Municipal Railway Rolling Stock, Way and Structures, Shops and Garages*, July, 1966; FMC Corporation, *Final Report: Inventory, Evaluation and System Planning of the San Francisco Municipal Railway Powerplant*, August, 1966).

FIGURE 9

HOURLY DISTRIBUTION OF TRANSIT RIDERS

BY TYPE OF SERVICE





PEAK-TO-BASE RATIO OF TRANSBAY SERVICE (LOWER LEFT) IS FIVE TIMES HIGHER THAN FOR LOCAL SERVICES, EITHER MUNI OR AC TRANSIT. FURTHER, MUNI STREETCAR OPERATIONS HAVE HIGHER PEAK HOUR CHARACTERISTICS THAN BUS OR TROLLEY COACH ROUTES. HOME-TO-WORK TRAVEL ACCOUNTS FOR THE HIGH PEAK CHARACTERISTICS OF BOTH TRANSBAY AND STREETCAR SERVICES.

equipment, from reconditioning of all motors to complete rebuilding of cable cars. The adequacy of each facility is summarized as follows:

Division	Bldg. Age in yrs.	Useful Life in yrs.	Bldg. Cond.	Vehicle Storage	Hoists and Pits
Kirkland	16	30	Fair	Inadequate	Inadequate
Ocean	17	30	Fair	Inadequate	Marginal
Potrero	50	25	Good	Generous	Adequate
Presidio	53	25	Good	Adequate	Adequate
Geneva	60	0	Poor	Adequate	Adequate
Washington-Mason	60	25	Fair	Adequate	Inadequate
Elkton Shops	60	0	Poor	Inadequate	Adequate
24th and Utah	60	0	Poor	Inadequate	Inadequate

The following conclusions were reached as a result of the study of maintenance functions at all divisions:

- All facilities are exceptionally crowded causing double shifts on overhaul, interference with housekeeping and cleaning of vehicles at all divisions, and shifting of maintenance and storage to other divisions, etc. The lack of operating space in yards and streets has caused exaggerated incidences of body damage which strains even more the limited body shop facilities.
- The requirement of space for transit operations has become critical; any further cutbacks for BARTD or city facilities at the expense of Muni will jeopardize the ability to maintain the fleet properly or to continue operating as a system.
- High maintenance on bus power trains and brake linings resulting from grades on San Francisco routes imposes a double load compared to other transit properties.
- Outmoded equipment requires Muni to provide maintenance of these vehicles by obtaining spare parts through cannibalism, or manufacturing parts through expensive castings and/or machining, especially for White buses, PCC streetcars and trolley coaches.

4. *Signal and Control Systems.* Speed control and safety are provided for by two-aspect block signals in Twin Peaks and Sunset Tunnels; the cable car system has four types of signals; and the central radio control room at Presidio Division houses the main supervisory control facilities. All equipment signal systems are elementary and adeqaute for the present operation.
5. *Powerplant and Substation Equipment.* Muni presently operates and maintains seven substations and the power distribution systems for trolley coaches and streetcars.

   The present powerplants are the result of original Muni facilities and the acquisition of private companies. Portions of the system D.C. power requirements are obtained from the Pacific Gas and Electric Company (PG&E). The substations are all located in the city of San Francisco and contain three types of equipment for the supply of 600 V D.C., (1) three substations with motor generator sets, (2) two substations with rotary converters, and (3) two relatively modern substations with mercury-arc rectifiers. The five substations with rotary equipment are manned while in operation, and the two rectifier substations are unattended.

   The adequacy of the substation buildings and equipment is summarized as follows:

Substation	Bldg. Age in yrs.	Useful Life in yrs.	Bldg. Cond.	Adequacy of Major Equipment
Bryant	60	0	Fair	Marginal
Downtown	45	16	Good	Good
Richmond	43	7	Fair	Inadequate
San Jose	60	0	Poor	Inadequate
Turk	60	0	Poor	Marginal
West Portal	13	36	Excellent	Good
Outer Mission	0	30	Excellent	Good

6. *Power Distribution System* for Muni streetcar and trolley coach lines comprises three classes of property: poles and fixtures, underground conduits and distribution lines. Field inspection reveals these items to be in reasonably good condition, adequately maintained and suitable for 15 to 20 years of service life. For both classes of operating equipment, it is likely that the power distribution facilities will outlast the rolling stock.

AC Transit Operating and Plant Facilities

The AC Transit system is made up of rolling stock and garages acquired from the Key System in 1960, augumented by buses purchased by the District.

The system operates approximately 77,000 scheduled miles of service in both transbay and East Bay service on weekdays, subdivided among three operating divisions as follows:

	Division #2	Division #3	Division #4	Total
Weekdays	28,000	13,740	35,207	76,947
Saturdays	18,614	6,384	17,412	42,410
Sundays	14,180	4,622	11,557	30,359

As shown here, Saturday service is about 55% of weekday operations while Sunday service is less than 40%.

In January 1967, AC Transit had 685 buses and 1,019 bus operators distributed among these three divisions:

Division #	No. of Buses	No. of Operators
2	248	401
3	137	178
4	300	440
TOTAL	685	1,019

To provide this service the following rolling stock and shop and garage facilities are required:

1. *Rolling Stock* is an all-bus fleet of 685 diesel coaches. 400 are new vehicles acquired since 1960; the remainder are early postwar vehicles acquired in 1947-1958 which are used principally in peak operations. 112 buses are air-conditioned.
2. *Shops and Garages.* Maintenance and service of vehicles are provided at three operating divisions.
   - The principal division, #2, is located at 45th and San Pablo Avenue, Emeryville, and serves routes in Berkeley, Oakland, Alameda and East Oakland.
   - Division #3 in Richmond is the service and maintenance base for routes operating from the northern corridor and most of the service as far south as University Avenue.
   - Division #4 is located in East Oakland for the accommodation of lines south of East Oakland down to Hayward and Fairway Park.

   All three divisions have facilities for service and running repairs, together with dispatching and operators' quarters for the transportation plant. The overhaul shops are located at Division #2, as well as general transportation facilities including Schedule Department, Purchasing and Stores, Maintenance Manager, Charter Department and other planning activities. These three operating and maintenance depots have been modified in recent years in keeping with the overall growth of the Transit District. They are well equipped with modern maintenance and service needs and entirely adequate for the AC Transit fleet.
3. *Transbay Terminal in Downtown San Francisco* is the western limit of AC Transit's transbay service. As previously pointed out, a substantial portion of transit riders from the East Bay transfer to Muni lines at this point. In addition to extensive passenger facilities, the Terminal has a direct elevated ramp to the Bay Bridge which AC Transit uses for midday storage of approximately 150 coaches in downtown San Francisco. This Transbay Terminal is a leased facility owned by the California Division of Bay Toll Crossings.

CHAPTER 5

Present Fare Systems

FARES are perhaps the most sensitive aspect of a transit system, reflecting a balance between political considerations and the need for operating revenues. In the Bay Area, this sensitivity is evident in both Muni and AC Transit operations. Despite continual operating deficits, both have continued with obviously low fares over the past several years. The Muni and AC Transit fare plans differ both in type and amount, and there is no provision for interchange between these separate systems.

Nature of Present Fare Plans

The wide variety of fare plans now in effect for transit operations can be grouped into three broad categories:

1. Flat-fare plans under which a uniform charge applies to any ride within the service area.
2. Zone-fare plans under which the service area is divided into segments, with the basic fare applicable to a one-zone ride and additional fare increments added for each subsequent zone traversed.
3. Point-to-point fare plans under which individual fares are determined between each two points on the system, with the amount of fare varying with length of ride.

While the three basic approaches to fares are mutually exclusive as described above, they frequently blend into one another in application. Thus, for example, it is not unusual to superimpose a transfer charge on a flat-fare plan. This is a move toward the zone-fare principle, since transfer journeys are generally longer than single-vehicle rides. Conversely, zone-fare plans sometimes embrace substantial overlaps between fare zones, a compromise with flat-fare plan for the area affected.

Bay Area transportation systems fare plans fall under each of the three categories, reflecting differences in emphasis on the part of the governing body or agency in each community. The San Francisco Municipal Railway has as pure a system of flat fares as can be found in the transit industry. Ninety-four percent of passenger revenue on the Muni system is accounted for by passengers paying the basic 15-cent fare. Transfers are free, so that there is a true citywide 15¢ fare for any transit journey. In view of the fully developed, tightly knit character of San Francisco, a flat fare is obviously the most desirable plan.

AC Transit has zone fares. However, the central or first fare zone on the system is so large as to approach an area flat-fare plan for a substantial portion of the East Bay population served. More than 80% of the journeys on the East Bay portion of the AC Transit system are single-zone journeys.

The Southern Pacific Railroad has a zone plan for fares between San Francisco and San Jose. There are six zones in the 47-mile length of this rail line with a minimum cash fare of 60¢ to downtown San Francisco.

Greyhound fares between Oakland and other East Bay communities and between San Francisco and East Bay areas are established on the basis of distance traveled.

The BARTD fare plan as proposed in the 1962 Composite Report[1] is truly a composite arrangement tailored to the existing flat fare in San Francisco, to the large central zone fare plan on the East Bay and generally a point-to-point fare schedule beyond and between these areas. It is a blend of the several basic approaches to transit fare planning. With the automatic fare collection techniques which are contemplated for BARTD, there is, of course, full opportunity to apply varying fare structures and, in fact, to apply the point-to-point principle to as great an extent as may be desired.

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[1] Parsons Brinckerhoff-Tudor-Bechtel, Smith, Barney & Co., Stone & Youngberg, Van Beuren Stanbery, *The Composite Report, Bay Area Rapid Transit,* May, 1962.

Nature of Fare Plans in Other Major Metropolitan Areas

The dominant transit systems in many of the largest cities in the country apply a flat-fare principle consistently. These include, for example, New York, Chicago, Philadelphia, Detroit, and Boston. In several of these cities there are a few suburban routes or route extensions which carry an added zone fare increment. These exceptions are insignificant in the total picture. The only meaningful departure from a true flat fare arrangement is in the matter of transfer journeys. Chicago, Philadelphia and Detroit charge 5¢ for a transfer. In most sections of New York City and in Boston, a transfer is not permitted between surface lines and rapid transit routes, a combination affecting a great many riders. Thus, a feeder surface and rapid transit journey involves the payment of two fares. In major U.S. cities having rapid transit facilities, there is either a charge for transfer between surface and rapid transit, or separate fares are required for each vehicle. For single-vehicle trips, the major transit systems identified above have a flat-fare plan.

Table 18

ZONE LENGTHS AND FARES
Transit Systems Serving Major United States Cities

	Basic Adult Fare				
City	Cash	Unit Token Rate	Approximate Central Zone Length (miles)	Approximate Length of Added Zones (miles)	Fare per Added Zone
Los Angeles	30¢	–	4	2 to 2-1/2	8¢
Baltimore	25¢	25¢	6	various	10¢
Houston	30¢	25¢	2-1/2	2-1/2	5¢
St. Louis	30¢	$3.75 weekly pass	7	2	10¢ or 2/15¢
Milwaukee	30¢	25¢ and $3.00 weekly pass	5-1/2	1	5¢
Dallas	23¢	21.25¢	3	3	5¢
Pittsburgh	30¢	weekly permit - $1.90 plus 10¢ per ride	6	1	-
San Antonio	20¢	19¢	2-3/4	1-1/2	5¢
San Diego	30¢	27.50¢	4.6	2.6	10¢
Seattle	25¢	25¢	5	4	5¢
Buffalo	25¢	25¢	5-1/2	2.2	10¢ first suburban zone 5¢ other zones
Cincinnati	30¢	25¢ and weekly permit - $1.10 plus 15¢ per ride	4	2	5¢
Atlanta	25¢	–	5	3	5¢

SOURCE: American Transit Association.

Transit systems in several other major U.S. cities are zoned in varying degrees. Illustrative zone lengths and zone fares in a number of large urban areas are shown in Table 18. Several transit systems shown have fare structures with a basic 30¢ adult cash fare. Understandably, the central zone limits on these are relatively distant from the downtown core area, generally six to seven miles from the CBD. In those instances, however, where the basic fare remains at 20¢ or 25¢, the approximate length of the central fare zone is usually in the range of three to five miles. Subsequent zones beyond the central zone are generally in the range of one to three miles in length and the charge per zone normally is 5¢.

Muni Fares

The present fares on Muni have been in effect since 1952, as follows:

Adult Fare	15¢
School and Children's Fare	5¢
Shoppers' Shuttle	5¢
Sunday and Holiday Tour Tickets	50¢

The basic 15¢ fare is universal: there are no zones. School fares are sold at 10 for 50¢, in the form of a punch ticket. Two shoppers' shuttle routes are operated at a 5¢ fare, good from 10:00 A.M. to 3:30 P.M., without transfer privileges. The Sunday and Holiday Pass is sold for 50¢ and is good for unlimited riding.

A special baseball fare applies for service to Candlestick Park consisting, essentially, of two fares. Postal service employees ride the Muni System without payment of fare, for which reimbursement is received by the system. Muni employees and police and fire department employees receive free transportation.

AC Transit Fare Structure

The basic elements of the AC Transit fare plan have been substantially unchanged since the formation of the public transit operation in the East Bay area six years ago. AC Transit instituted a 10¢ child's fare when the District began operations. Some minor changes were made by adding a zone charge for extension into a new area (1961), by instituting a Sunday-Holiday Pass (1962), and the "Shop-A-Round Pass" in downtown Oakland (1964). An increase in fares was inaugurated at the start of 1966 with a change in child and school rate from 10¢ to 15¢ and a small increase in the commute fares for transbay trips. However, the basic fare has remained the same for six years, despite a 38% rise in wage levels.

The present fare plan is a zone arrangement extending north and south from the Central Zone, the core of which is downtown Oakland. There is one zone to the north of the Central Zone and there are three additional zones to the south.[2]

Local Fares on AC Transit

The basic fare on AC Transit local lines is 25¢ cash or a reduced fare of 20¢ (five tokens for one dollar). The additional zone increment is 10¢, except for rides to and from the third zone south where the additional fare is 5¢. A charge of 13¢ per zone is made for overriding zone limits. The table below lists the adult fares in effect for single and multi-zone rides on local

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[2] Zone overlaps, permitting a single-fare ride in portions of adjacent zones, apply between the second and third, and between the third and fourth zones to the south. An additional overlap exists between the Central Zone and the added zone to the north.

ADULT FARES

AC TRANSIT LOCAL LINES

Zone	Second-North	Central	Second-South	Third-South	Fourth-South
Second-North	25¢ (20¢)	35¢ (30¢)	40¢ (35¢)	50¢ (45¢)	60¢ (55¢)
Central	35¢ (30¢)	25¢ (20¢)	35¢ (30¢)	40¢ (35¢)	50¢ (45¢)
Second-South	40¢ (35¢)	35¢ (30¢)	25¢ (20¢)	35¢ (30¢)	40¢ (35¢)
Third-South	50¢ (45¢)	40¢ (35¢)	35¢ (30¢)	25¢ (20¢)	25¢ (20¢)
Fourth-South	60¢ (55¢)	50¢ (45¢)	40¢ (35¢)	25¢ (20¢)	25¢ (20¢)

AC Transit lines. (The figures in parentheses represent the fare when a 20¢ token is used, the balance being paid in cash on multi-zone trips.)

The children's and school fare is 15¢ systemwide. There is also a 60¢ Sunday and Holiday Pass which permits unlimited riding.

A "Downtown Shop-A-Round Pass," good for unlimited riding in the central business districts of Oakland and San Leandro is available for 25¢ or a 20¢ token. The pass is good between 9:00 A.M. and 3:00 P.M., Monday through Saturday, and can be used for the return trip home.

In addition, there are several special categories of fares, including 20¢ and 25¢ "Golden Gate Specials," applicable to riders between Berkeley and Golden Gate Fields. Postal employees for whose rides AC Transit System is paid and employees and dependents who ride free round out the fare classifications on the East Bay Lines.

Transbay Fares on AC Transit

The fare for a transbay ride on AC Transit between the Central Zone on the East Bay and the Transbay Terminal in San Francisco is 50¢ cash or 45¢ on a commute ticket.

Fares for rides between the East Bay area and San Francisco take the form of cash fares (or tickets at the cash fare rate), plus a reduced round-trip rate from Zones Three and Four South, and a reduced-rate 20-ride book for regular commuters from any East Bay zone.

Transbay fares are zoned in the same manner as local trips. The table below indicates the fare rates now in effect between San Francisco and East Bay communities.

ADULT FARES
AC TRANSBAY LINES

To or From San Francisco	Central Zone	Zone Two North or South	Zone Three South	Zone Four South
Adult	50¢	60¢	65¢ or $1.20/RT	75¢ or $1.40/RT
20-Ride Commute	$9.00 (45¢)	$10.50 (52.5¢)	$12.00 (60¢)	$12.00 plus 10¢/ride (70¢)

Reduced rates for children through age 16 range from 20¢ to a maximum of 30¢ for transbay rides.

Treasure Island is included in the Local Central Zone and the same fares apply to East Bay points. Between Treasure Island and San Francisco, the local single-zone fare is also applicable.

There are special fares applicable to football and race track service. Employees and their dependents receive free transportation on the transbay routes as well as on the East Bay lines.

Greyhound Fares

Greyhound provides extensive suburban commuter service in the Bay Area. Of particular interest are the Greyhound operations in Contra Costa and San Mateo Counties—areas in which the coordinated transit network will have an impact.

Greyhound tariffs provide for both cash and monthly commuter fares. The service areas are zoned from San Francisco, with 11 zones between San Francisco and Antioch in Contra Costa County, and 13 zones southward along the Peninsula to San Jose. Distances involved are approximately 50 miles from San Francisco to San Jose and 48 miles from San Francisco to Antioch.

The minimum Greyhound fare is 30¢; zone cash fares range upward to $1.65 between San Francisco and San Jose. Monthly commutation tickets, providing for one round trip on each day of the month, are sold for trips between San Francisco and the third through the seventh zones in Contra Costa County, with the price ranging between $18.20 from Orinda and $27.50 from Concord.

Twenty-ride commute books are available for trips between San Francisco and Peninsula communities. The rates are scaled between $5.60 from Daly City to $12.00 from San Jose.

Southern Pacific Railroad Fares

The commuter operation of the Southern Pacific Railroad between San Francisco and San Jose is divided into six fare zones. The one-way cash fares range from $.60 in the first zone to $1.45 in the sixth zone. Corresponding round-trip fares are $1.10 and $2.59. Four types of commute plans are available: a 5-day commutation (good for unlimited riding between

Table 19

COMPARATIVE RATES OF FARE

Transit Systems Serving the Thirty-One Largest U.S. Cities

	Adult Fares					Student Fares	
City	Cash	Ticket or Token	Pass or Permit	Minimum Fare on Basis of 10 Rides per Week	Transfer	Cash	Ticket or Token
Publicly Owned Transit Systems							
New York	20¢	–	–	20¢	None or Free	H.S. -10¢ per Round Trip (a)	Grade School- $1 per Month (a)
Chicago	25¢	–	–	25¢	5¢	12¢ (a)	–
Los Angeles	30¢	–	–	30¢	Free	15¢	–
Detroit	25¢	4/90¢	–	22.5¢	5¢	15¢	–
Cleveland	25¢	–	$3.75- Wkly. Pass	25¢	3¢	15¢	4/50¢
St. Louis	30¢	–	$3.75- Wkly. Pass	30¢	5¢		$2 per Week
SAN FRANCISCO	15¢	–	–	15¢	Free	–	10/50¢
Boston							
Rapid Transit	20¢	–	–	20¢	None or Free	10¢	–
Surface	10¢	–	–	10¢	None	10¢	–
Dallas	23¢	4/85¢	–	21.25¢	Free	–	20/$2.00
Pittsburgh	30¢	–	$1.90-Wkly. Permit plus 10¢ per Ride	29¢	5¢	–	$4 per Month plus 10¢ per Ride
San Antonio	20¢	5/95¢	–	19¢	2¢	10¢	20/$1.50
Seattle	25¢	–	–	25¢	Free	20¢	–
Memphis	20¢	–	–	20¢	5¢	10¢	–
OAKLAND	25¢	5/$1.00	–	20¢	Free	15¢	–
Privately Owned Transit Systems							
Philadelphia	25¢	–	–	25¢	5¢	–	10/85¢
Baltimore	25¢	–	–	25¢	5¢	15¢	–
Houston	30¢	8/$2.00	–	25¢	Free	10¢	18/$1.50
Washington	25¢	4/98¢	–	24.5¢	Free	–	10/$1.00 (a)
Milwaukee	30¢	6/$1.50	$3.00 Weekly Pass	25¢	Free	–	$1.50 per Week
New Orleans	10¢	–	–	10¢	Free	–	–
San Diego	30¢	4/$1.10	–	27.5¢	Free	25¢	4/$1.00
Buffalo	25¢	–	–	25¢	5¢	15¢ (a)	–
Cincinnati	30¢	4/$1.00	$1.10 Wkly. Permit plus 15¢ per ride	25¢	5¢	20¢	10/$1.50
Denver	30¢	–	–	30¢	5¢	20¢	3/55¢
Atlanta	25¢	–	–	25¢	Free or 5¢	10¢	–
Minneapolis	25¢	–	–	25¢	Free	15¢	–
Indianapolis	25¢	–	–	25¢	5¢	H.S. 15¢ G.S. 10¢	–
Kansas City	30¢	–	–	30¢	3¢	–	–
Columbus	30¢	4/$1.35	–	27¢	Free	–	–
Phoenix	25¢	–	–	25¢	5¢	–	20/$3.50
Newark	20¢	–	–	20¢	10¢	12¢	–

SOURCE: American Transit Association

(a) In addition to fare box revenues from student fares, system receives or may be eligible for supplementary non-transit revenues to defray cost of carrying students.

TRANSIT FARE LEVELS IN OTHER CITIES

Among the 30 largest cities in the country, only San Francisco and New Orleans retain adult transit fares below 20¢ (Table 19). In both cases, substantial subsidies are provided from non-transit sources—from electric and gas revenues in New Orleans and from tax funds in San Francisco. Excluding San Francisco, 22 of the 29 largest cities in the country now have adult cash fares of 25¢ or more. Taking into account the reduced rates which are available in some communities through tickets, tokens or weekly passes, the minimum adult fare for regular riders is 25¢ or more on most major systems today. A summary of the minimum fare for adults, excluding San Francisco-Oakland, is as follows:

Minimum Adult Fare on the Basis of 10 Rides per Week	Number of Transit Systems	Cumulative Number of Systems
30¢	4	4
Over 25¢ but less than 30¢	3	7
25¢	13	20
Over 20¢ but less than 25¢	3	23
20¢	4	27
Under 20¢	2	29

Most large transit systems now charge for transfers, typically five cents. On the New York and Boston transit systems where the basic fare is 20¢, there is no transfer privilege for the bulk of the journeys which involve two vehicles. Thus, in New York, there is no transfer permitted betwen the rapid transit and surface lines, although a free transfer is permitted at some points between rapid transit routes. In Boston, no surface-rapid transit transfers are permitted. The fare is 20¢ for a rapid transit ride and 10¢ for each surface vehicle in a journey.

The 5¢ fare for children and students in San Francisco also is well below the level prevailing in other cities. The children's fare on other properties is generally in the 10¢-15¢ range. The same is true of student rates. In a number of cities, student fares are augmented by payment of non-transit revenues to make up the difference between the student fare and the full adult rate.

Mondays and Fridays); weekly commutation (good for unlimited riding Sunday to Saturday inclusive); 20-ride family ticket; and a monthly commutation good for unlimited riding daily. Rates of fare for the monthly commutation ticket (seven-day) range from $15.25 in the first zone to $30.50 in the sixth zone.

The Southern Pacific Railroad has filed for appreciable increases in cash and commuter fare rates.

VOLUME OF RIDING BY FARE CLASSIFICATION

Distribution of Muni Riding by Fare Classifications

More than 86% of the revenue passengers and 94% of the passenger revenue on the Muni system are accounted for by passengers paying the basic 15¢ fare. The only other significant fare category is the 5¢ school rate, which accounts for 11.4% of revenue passengers and 4.1% of the revenue. The 5¢ Shoppers' Shuttle rate accounts for approximately 1% of system revenue passengers. The remaining passengers and revenue are distributed among small groups, such as the 50¢ Sunday-Holiday Pass and special fares for baseball games (Table 20).

AC Transit Fare Classifications

The AC Transit fare schedule is as complex as the Muni plan is simple. While Muni has really only one classification of fares, plus a relatively small number of school and Shoppers' Shuttle passengers, AC Transit has many fare categories. Approximately 83.6% of the revenue on the East Bay lines is derived from the 20¢ token rate and the 25¢ cash fare passengers (Table 21).

On the transbay lines (Table 22), the dominant fares are the 50¢ cash rate from the Central Zone on the East Bay to downtown San Francisco (23% of the passengers), the 20-ride commute ticket between the Central Zone on the East Bay and downtown San Francisco (29.8% of the riders), and the one-way 50¢ ticket between the Central Zone and downtown San Francisco (10.8% of the passengers). These three categories accounted for more than 70% of the revenue on all transbay routes in the fiscal year ended June 30, 1965.

Fare Zone Distribution of AC Transit Passengers

The First or Central Zone on the AC system covers a large area. It embraces most of Oakland and Alameda and extends to the north to include Berkeley, West Berkeley and communities beyond, including Tilden Park, Cragmont, Kensington, Thousand Oaks, and Albany. The northern boundary of the Central Zone is seven to nine route miles from downtown Oakland.

To the south or east, the Central Zone extends from Oakland to include Piedmont, Forest Park, Redwood Park, Oakmore, Dimond, Fruitvale, Melrose, and a number of other communities. The distance from downtown Oakland to the southern boundary of the Central Zone is approximately six and one-half to seven route miles. The total length of ride which can be made at the single-zone fare within the Central Zone is approximately 16 miles.

The Second Zone to the south embraces Eastmont, Elmhurst, Sheffield Village, San Leandro, and several other communities. It is approximately five miles long. The Third Zone to the south includes principally Hayward and Castro Valley and is about seven miles in length. The Fourth and final zone to the south extends to Fairway Park.

It is apparent that there are opportunities for additional zoning on the AC system, particularly in view of the length of ride available at the basic fare in the Central Fare Zone.

The passenger records of AC Transit do not reveal the distribution of passenger riding from zone to zone throughout the system. A separate analysis has been made of the origin-destination survey data in order to define the pattern of average daily riding among the several zones.

Several significant points emerge from this analysis as illustrated in Table 23:

- 59% of all adult journeys on the AC Transit system are single-zone trips.
- Over half (53.8%) of AC adult passengers ride entirely within the Central Zone on the East Bay.
- Nearly three-fourths of all East Bay trips are single-zone and are confined to the Central Fare Zone.
- Four out of five East Bay trips are single-zone journeys.
- More than 75% of the multi-zone trips on the East Bay are destined to the Central

Table 20

DISTRIBUTION OF MUNI PASSENGERS AND REVENUE
BY FARE CLASSIFICATION
Year Ended June 30, 1965

Fare Classification	Passengers	Percent of Total	Revenue	Percent of Total
15¢ Cash	121,809,150	86.271%	$18,271,372.50	93.971%
8-1/3¢ Tokens	1,361	.367	77,741.82	.400
15¢ Tickets	517,523			
5¢ School	16,052,528	11.369	802,626.40	4.128
5¢ Shoppers' Shuttle	1,443,312	1.022	72,165.60	.371
5¢ Baseball	35,402	.025	1,770.10	.009
15¢ Baseball	127,989	.091	19,198.35	.099
30¢ Baseball	269,152	.191	80,745.60	.415
50¢ Sunday-Holiday Pass	452,740	.321	45,274.00	.233
Postal Employees	484,360	.343	72,654.00	.374
TOTAL	141,193,517	100.000%	$19,443,548.37	100.000%

Table 21

DISTRIBUTION OF AC TRANSIT FARES AND REVENUE
BY FARE CLASSIFICATION — EAST BAY ROUTES
Year Ended June 30, 1965

Fare Classification	Number of Fares	Percent of Total	Revenue	Percent of Total
Regular Cash, Ticket and Token Fares				
10¢	11,509,198	27.947%	$1,150,919.80	15.083%
13¢	102,463	.249	13,320.19	.174
20¢	17,959,266	43.610	3,591,853.20	47.074
25¢	11,158,715	27.096	2,789,678.75	36.561
30¢	962	.003	288.60	.004
35¢	2,742	.007	959.70	.013
40¢	355	.001	142.00	.002
Other Fares				
60¢ Sunday-Holiday Pass	72,563	.176	43,537.80	.570
20¢ Golden Gate (Special)	29,227	.071	5,845.40	.077
25¢ Golden Gate (Special)	31,321	.076	7,830.25	.103
Postal Employees	-	-	36,780.60	.482
Refunds, Adjustments, etc.	-	-	(10,922.29)	(.143)
Employees and Dependents	314,735	.764	-	-
TOTAL	41,181,547	100.000%	$7,630,234.00	100.000%

Zone. The most important zone in producing multi-zone journeys is the Second Zone South, followed by the Third Zone South, then by the Second Zone North, with a very small number of trips originating from the Fourth Zone South.

- Only 4,400 multi-zone trips on the East Bay are made daily to zones other than the Central Zone. Overwhelmingly, these are two-zone rides. There are only about 1,300 three-zone trips daily, and approximately 170 four-zone rides. The origin-destination survey revealed no five-zone rides.
- The total number of journeys to San Francisco is equal to about 37% of the aggregate travel on the East Bay lines.
- More than three-fourths (76.8%) of the San Francisco trips originate in the Central Fare Zone on the East Bay. The order of magnitude of trips to San Francisco from other zones is the same as their relative standing in producing trips to the Central Zone on the East Bay side. The Second Zone South produces more trips to San Francisco than any other outer zone. The other zones, i.e., the Third Zone South, the Second Zone North, and the Fourth Zone South, follow in that order in the number of trips which each produces to San Francisco.

Transfer Arrangements and Transfer Volumes

Both Muni and AC Transit provide free transfer privileges. The transfer regulations on both systems are designed to permit a passenger to travel from one part of the system to another by the shortest route, continuing in the same general direction.

On the Muni arterial lines, the transfer ratio averages 36.4%, while the crosstown and feeder

Table 22

DISTRIBUTION OF AC TRANSIT FARES AND REVENUE BY FARE CLASSIFICATION — TRANSBAY ROUTES

Year Ended June 30, 1965

Fare Classification:	Rate of Fare	Number of Fares	Percent of Total	Revenue	Percent of Total
Cash:					
School	10¢	602,736	4.982%	$ 60,273.60	1.173%
Child - Zone 1	20¢	40,387	.334	8,077.40	.157
Child - Zone 2 and 3	25¢	4,707	.039	1,176.75	.023
Yerba Buena Island	25¢	644,088	5.324	161,022.00	3.133
Local	25¢	302,919	2.504	75,729.75	1.473
Adult - Zone 1	50¢	2,781,617	22.992	1,390,808.50	27.056
Adult - Zone 2	60¢	380,963	3.149	228,557.80	4.447
Adult - Zone 3	65¢	23,951	.198	15,568.15	.303
Golden Gate Fields	85¢	9,676	.080	8,224.60	.160
Tokens:	20¢	738,027	6.100	147,605.40	2.871
Tickets:					
Toll Plaza	20¢	13,460	.111	2,692.00	.052
20 - Ride - Zone 1	43¢	3,605,509	29.802	1,550,368.87	30.160
20 - Ride - Zone 2	50.5¢	769,121	6.357	388,406.10	7.556
20 - Ride - Zone 3	58¢	294,818	2.437	170,994.44	3.326
One-way - Zone 1	50¢	1,306,980	10.803	653,490.00	12.713
One-way - Zone 2	60¢	159,063	1.315	95,437.80	1.857
One-way - Zone 3	65¢	34,059	.282	22,138.35	.431
One-way - Zone 4	75¢	632	.005	474.00	.009
Round Trip - Zone 3	60¢	152,753	1.262	91,651.80	1.783
Round Trip - Zone 4	70¢	10,442	.086	7,309.40	.142
Football - Zone 1	60¢	506	.004	304.60	.006
Football - Round trip	57.5¢	9,402	.078	5,406.15	.105
Golden Gate Field - Round trip	75¢	55,305	.457	41,479.75	.807
Child - Zone 1	20¢	75,983	.628	15,197.60	.296
Child - Zone 2 and 3	25¢	21,459	.177	5,364.75	.104
Child - Zone 4	30¢	89	.001	26.70	.001
Adjustments, Refunds, etc.		8,310	.069	(7,408.26)	(.144)
Total		12,046,962	—	$5,140,398.00	—
Employees and Dependents		51,367	.424	—	—
TOTAL		12,098,329	100.000%	$5,140,398.00	100.000%

Table 23

DISTRIBUTION OF AC TRANSIT ADULT PASSENGERS BY FARE ZONE
Based on Origin-Destination Survey

	Average Daily Passengers	Percent of System Revenue Passengers
JOURNEYS IN THE EAST BAY AREA		
Single-Zone Journeys (25¢ or 5/$1.00 Token):		
Totally within the Central Zone	67,372	53.79%
Totally within the Second Zone North	2,924	2.33
Totally within the Second Zone South	920	0.73
Totally within the Third & Fourth Zones South	2,713	2.17
Total Single-Zone Journeys	73,929	59.02%
Multi-Zone Journeys:		
To Central Zone:		
From Second Zone North(35¢ or T. + 10¢) (a)	2,639	2.11%
From Second Zone South (35¢ or T. + 10¢)	6,722	5.37
From Third Zone South (40¢ or T. + 15¢)	3,698	2.95
From Fourth Zone South (50¢ or T. + 25¢)	357	0.29
Total Multi-Zone Journeys to Central Zone	13,416	10.72%
To Other Zones:		
Two-Zone Rides (35¢ or T. + 10¢)	2,912	2.32%
Three-Zone Rides (40¢ or T. + 15¢)	1,295	1.03
Four-Zone Rides (50¢ or T. + 25¢)	167	0.13
Five-Zone Rides (60¢ or T. + 35¢)	0	0.00
Total Multi-Zone Journeys to Other Zones	4,374	3.48%
Total Multi-Zone Journeys	17,790	14.20%
Total Journeys in the East Bay Area	91,719	73.22%
JOURNEYS TO SAN FRANCISCO		
From the Central Zone (50¢ or 45¢ C.T.) (b)	25,763	20.57%
From Second Zone North (60¢ or 52.5¢ C.T.)	1,727	1.38
From Second Zone South (60¢ or 52.5¢ C.T.)	3,116	2.49
From Third Zone South (65¢ or 60¢ C.T.)	2,389	1.91
From Fourth Zone South (75¢ or 70¢ C.T.)	546	0.43
Total Journeys to San Francisco	33,541	26.78%
TOTAL	125,260	100.00%

(a) 35¢ cash or token plus 10¢.

(b) 50¢ cash or 45¢ commuter ticket.

lines have somewhat greater transfer use, averaging 64.1% and 49.0%, respectively.[3]

AC Transit does not compile figures on transfer riding on each of its routes. However, it has been possible to derive an estimate of the total use of each line from an analysis of the origin-destination survey results. The transbay lines have an average transfer ratio of 13.0%, while the East Bay arterial lines average 30.5%. Ratio of transfer passengers to revenue passengers is 41.7% on crosstown routes and 39.3% on routes classified as essentially feeder lines.

Joint or Combination Fares

One aspect of the Northern California Transit Demonstration Project is the recommendation of a fare structure and consideration of fare collection systems both for single-vehicle and multi-vehicle journeys when BARTD is superimposed on the Muni and AC Transit systems. There are no joint fare arrangements of any type between the Muni and AC lines. While there is a substantial interchange of passengers between the two systems at the San Francisco terminal of the transbay routes, the fares are totally separate, with no combination arrangement in any form.

There is no fare plan in other cities which can serve as a model for the Bay Area. Consideration has been given to what is now being done in other major metropolitan areas with respect to combination fares. A study of fares in the 22 largest metropolitan areas of the country indicates that the transit systems in 18 of these have no combination fares with other transportation systems. Among the 18 major properties without joint fares are those in Boston, Cleveland, and New York—cities in which various suburban carriers feed rapid transit lines, but do so in all instances under separate fare structures.

Only four major cities now have any form of combination fare in effect. These are Los Angeles, Philadelphia, Pittsburgh and Washington.[4]

The combination fares in Los Angeles and Pittsburgh are confined in each instance to one particular situation and are of minor importance.

In Philadelphia, combination fares are somewhat more significant. Principally, they pertain to feeder bus operations to commuter railroad stations and joint arrangements on several suburban bus lines which are in effect the continuation of routes of the Philadelphia Transportation Company into outlying areas. The various joint tickets or combination fares are sold and collected manually. There is no automation involved.

The most fully developed joint fare arrangements in the nation are those in Washington under a program designed by the Washington Metropolitan Area Transit Commission in cooperation with private transit carriers. The joint fare tickets are sold by the bus drivers on each of the transit companies involved. There is no automation in the sale or collection of the joint fare tickets.

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[3] It is possible to determine from the passenger records of Muni the transfer ratios, i.e., the percentage relationship of transfer riders on each line to the revenue passengers on that route.

[4] Simpson & Curtin, *Technical Memorandum No. 51: Analysis of Present Fare Structure,* February, 1966.

CHAPTER 6

Present Transit Costs

Muni classifies operating costs into 287 sub-accounts divided among work functions—maintenance, transportation, administration, etc.—and between type of expenses—labor, materials, purchased service—as well as among vehicle types—buses, streetcars, etc. AC Transit omits the latter breakdown since it is an all-bus operation, but nevertheless it has 67 sub-accounts in its operating expense classifications. This detail is needed for effective transit management, but obviously is too unwieldy for planning purposes. At the same time, there is distinct need for more sophisticated measures than overall unit mileage operating costs.

A pioneer effort has been made in this study to develop an appropriate measure for projection of future costs among Bay Area transit systems by the design of a cost allocation model reflecting amount of service, operating speed, trip length and other service parameters in individual route performance. As a first step, the trend of major cost elements on the Muni and AC Transit systems was analyzed for recent years to determine normalized cost levels and rate of change annually. Thereafter, the allocation model was developed to serve as a basis for apportionment of expenses to individual routes and to evaluate unit cost variations induced by major route changes, as contemplated in subsequent network proposals.

Muni Unit Operating Costs in 1965

Aggregate operating costs for the Muni system in the fiscal year ended June 30, 1965 amounted to $1.057 per mile for all types of service. There were, of course, substantial cost variations among the several classes. Bus operations required 93.1¢, as compared with $1.045 per mile for trolley coach, $1.15 for streetcar and $4.966 for cable car operations. Two important factors accounted for this substantial difference on cable cars—two-man operation and much slower scheduled speed.

The cost of conducting transportation, principally wages of operators and street supervision, varied from 50¢ to 59¢ per mile for the three major classes of service.

General and miscellaneous costs aggregated 16.9¢ per mile. However, this system figure submerged a much higher cost for the cable car operation. While the other three classes of service had costs varying from 15¢ to 18¢ per mile for these items, cable car lines consumed nearly 72¢ per mile. The bulk of costs in the general and miscellaneous category is made up of various types of overhead labor expense, such as pension, sick leave, and Social Security, which accounts in part for the heavy apportionment to the cable car lines under two-man operation. Another significant cost under this general heading is claims expense, which varies from 1.7¢ to 2.5¢ per mile on the major services, but exceeds 13¢ per mile on cable cars.

The summary of operating expenses for all classes of Muni service together are shown for major account categories in Table 24, with both the cost for each category in cents per mile and relation of each item to total costs in percentage terms. In addition to the unit cost data, this analysis traces the annual percentage change in cost per mile for each category over the last four fiscal years. For the system as a whole, the annual rate of increase in operating expenses per mile has been 2.75%.

The largest single element of cost is the direct payroll of the operating employees. On this item, the trend has been relatively consistent among the several types of service. The annual rate of increase in operators' payroll per mile

Table 24

LEVEL AND TREND OF MUNI COST PER VEHICLE MILE
BY MAJOR ITEMS OF COST
Year Ended June 30, 1965 and Trend, 1961 to 1965

	Year Ended June 30, 1965		Annual Percent Change in Cost Per Mile				
Item of Cost	Cost per Mile	Percent of Total Cost	1961-1962	1962-1963	1963-1964	1964-1965	Four-Year Average
Transportation	55.54¢	52.53%	+ 3.71%	+ 4.41%	+ 3.94%	+ 5.65%	+ 4.43%
General and Misc.	16.93¢	16.01	+19.28	+ 8.96	+ 4.33	+ 0.30	+ 8.22
Equipment	11.15¢	10.55	+ 2.05	- 1.91	+14.90	+10.62	+ 6.42
Power	6.78¢	6.41	- 0.78	- 3.11	+ 3.05	+ 5.61	+ 1.19
Provision for Accidents	6.32¢	5.98	+ 0.79	- 0.63	+ 0.48	- 0.16	+ 0.12
Depreciation, Interest and Rents	5.16¢	4.88	- 6.02	-12.51	-22.27	-27.53	-17.08
Way and Structures	3.85¢	3.64	+ 3.53	0.00	+ 5.91	+13.24	+ 5.67
TOTAL	105.73¢	100.00%	+ 3.95%	+ 1.75%	+ 2.46%	+ 2.85%	+ 2.75%

has been between 4.3% and 4.8% for streetcar, trolley coach, and bus service, and slightly under 6% on the cable cars. Aggregate transportation expenses have been rising 2.5% to 5.3% on the three major types of service and at nearly 6.2% annually on the cable car lines.

As the rolling stock has continued to age in recent years, the cost of fleet maintenance has been rising sharply.[1] Power or fuel costs have remained relatively constant, with an annual increase of only 1.2% in mileage costs. Similarly, provision for accidents has shown no material change in unit cost.

Extraordinary expenses incurred in 1965 resulted in a substantial annual percentage rise in the cost of way and structures, principally on cable car lines. Actually, way and structures' expenses had been quite constant until this fiscal period, when they rose by nearly two-thirds as a result of a large-scale refurbishing program on the cable car system.

Provision for depreciation, interest, and rents has shown a steady and substantial decrease since 1961. With the property continuing to age, costs in this category have been declining at a rate of 17% annually. It is apparent that these costs must rise as needed equipment replacement is accomplished. Concurrent with future increases in these costs, there will be some reduction in unit costs of maintenance which, as noted earlier, have risen abnormally.

Alameda-Contra Costa Transit District

In the fiscal year ended June 30, 1965, total costs of operation of the AC Transit system amounted to 63.99¢ per mile. More than 70% of this total (44.9¢) was consumed in transportation and maintenance expenses, the bulk of which were wage costs (Table 25).

Next in order of magnitude was depreciation and amortization which accounted for 6-2/3% of total costs, followed by administrative and general expenses at approximately 4-2/3% of operating expenses. None of the remaining eight cost accounts listed on Table 25 represents as much as 5% of operating expense or 3¢ per mile.

In addition to the breakdown of 1965 operating costs per mile and their percentage distribution, Table 25 provides the year-to-year change for major expense categories, beginning with the 1963 fiscal period.

Most of the major cost items have been increasing at a rate between 3% and 5% annually; for total operating costs, the annual rate has been 3.75% upward.

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[1] For the last four years, the per-mile maintenance costs on the trolley car fleet have been rising at the annual rate between 7% and 14%, averaging more than 13% per year. Similarly, the cost of maintenance of engines, chassis, transmission and brakes on the bus fleet has been rising at an annual rate of 6% to 23.5%, averaging 13.2% per year since 1961.

Table 25

LEVEL AND TREND OF AC TRANSIT COST PER VEHICLE MILE BY MAJOR ITEMS OF COST

Year Ended June 30, 1965 and Trend, 1962 to 1965

	Year Ended June 30, 1965		Annual Percent Change in Cost per Mile			
Item of Cost	Cost per Mile	Percent of Total Cost	1962-1963	1963-1964	1964-1965	Three-Year Average
Transportation	36.36¢	56.82%	+ 5.61%	+ 1.87%	+ 4.09%	+ 3.86%
(Operators' Wages) (a)	(28.97¢)	(45.27)	(+ 6.48)	(+ 1.72)	(+ 4.36)	(+ 4.19)
Maintenance	8.56¢	13.38	+10.23	- 0.49	+ 3.63	+ 4.46
(Repairs to Rev. Equip.) (a)	(4.20¢)	(6.56)	(+17.45)	(- 5.90)	(+ 5.26)	(+ 5.60)
Deprec. & Amortization	4.27¢	6.67	+ 4.53	+ 2.30	+ 6.48	+ 4.44
Administrative & General	2.96¢	4.63	+ 6.77	- 5.99	+10.86	+ 3.88
Operating Taxes & Licenses	2.80¢	4.38	+11.86	+ 0.76	+ 5.26	+ 5.96
Welfare & Pensions	2.70¢	4.22	+18.38	+16.44	+ 5.88	+13.57
Insurance & Safety	2.37¢	3.70	-20.33	+ 5.44	- 5.95	- 6.95
Interest Payments	2.23¢	3.49	+23.81	- 8.47	- 6.30	+ 3.01
Public Information & Advertising	0.62¢	0.97	- 3.08	- 1.59	0.00	- 1.56
Traffic Solicitation	0.52¢	0.82	+ 6.38	- 8.00	+13.04	+ 3.81
Station Expense	0.30¢	0.47	0.00	+ 3.57	+ 3.45	+ 2.34
Operating Rents	0.29¢	0.45	+19.05	+ 8.00	+ 7.41	+11.49
TOTAL	63.99¢	100.00%	+ 6.11%	+ 1.30%	+ 3.85%	+ 3.75%

(a) This item is included in the account total in the line above.

The largest single cost element, operators' wages, rose at an average rate of 4.2% since 1962. With the further impact of an arbitration award in 1965, wage costs are increasing at an even greater rate currently. The same is true of welfare and pension expense, which was increasing at a higher than average rate as shown on Table 25 before being accelerated by the 1965 arbitration award.

COST ALLOCATION

The foregoing analysis and a careful study of work procedures led to the identification of five elements of primary value in allocating the various expense items. These five elements are: vehicle hours, vehicle miles, peak vehicle needs, miles of line, and passenger revenue. In its cost analyses, the Muni management has used the first two of these for allocating expenses to routes. AC Transit does not make any such allocation for planning purposes, although it uses the same two elements—vehicle miles and vehicle hours—in combination for quoting charter trip rates.

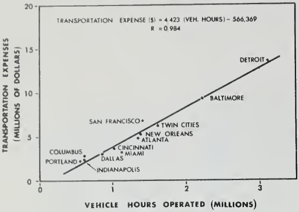
Vehicle Hours. Data were obtained from several bus systems throughout the United States to test the relationship between transportation expenses (the largest major account) and vehicle hours of service. As shown by Figure 22, a direct linear relationship prevails with a high degree of correlation. The coefficient of correlation was 0.984.

As previously indicated, the wages of operating employees represent by far the largest single element of cost in a transit system. On the Muni bus lines, they account for more than 41% of aggregate costs; on the AC system, operators' wages amount to over 45% of total expenses.

Employees engaged in operating the vehicles of both systems are paid on an hourly basis;

FIGURE 22

RELATIONSHIP BETWEEN TRANSPORTATION EXPENSES AND VEHICLE HOURS OPERATED



Data from major bus systems throughout the United States show a close relationship between transportation expenses (the largest cost account), and vehicle hours of service. A direct linear relationship prevails with a high degree of correlation. The coefficient of correlation is 0.984.

allocation of this wage expense, therefore, would be made on the basis of hours of service on each of the lines. The ideal method would be on pay hours of drivers for work performed on each route. The nearest available alternative is aggregate vehicle hours operated on each line. The latter was the basis used to allocate drivers' wages on both systems.[2] With respect to the Muni operation, wages of operating employees in each class of service (streetcar, cable car, trolley coach and bus) were allocated to each line based on the percentage relationship of vehicle hours operated on that line to the total vehicle hours for the class of service involved.

Two other important classes of expense have been allocated on a vehicle hour basis. Supervision of transportation operations is directly related to hours of service provided. Therefore, this item has been allocated on the basis of vehicle hours. The other major category allocated by vehicle hours, in addition to operating wages, includes the labor costs represented in sick leave, Social Security, pensions, health service, and such lesser labor costs as jury duty, military leave, and the like. While these costs are attributable to all classes of employees, the bulk of the amount is directly assignable to the largest group of workers on both systems, namely the operating force. Hence, such non-payroll labor costs were assigned in the same fashion as direct wages and charged to individual routes on the basis of vehicle hours.

Vehicle Miles. Many costs are related directly to the miles of operation on each route, including such items as power or fuel, tires, and maintenance of the vehicles. On electrically powered vehicles, the cost of rails, ties, track roadway maintenance labor, overhead and overhead feeders, are properly charged to each line on the basis of miles of service operated. Similarly, labor and material expense on vehicle bodies, brakes, engines, chassis, transmission and electric equipment for propulsion are a function of wear in terms of miles of service. These costs, together with supervision of equipment maintenance, were assigned to individual routes on the basis of vehicle miles operated.

Peak Vehicle Needs. While the bulk of operating expenses can appropriately be allocated on the basis of vehicle hours or vehicle miles, certain expense items do not vary as a function of either of these. Thus, for example, the cost of storage facilities for vehicles is a function of the *number* of vehicles required to operate the line, rather than miles or hours of service. Similarly, the expenses in servicing buses—fueling, washing, cleaning interiors, etc.—is more nearly a function of the number of vehicles than any other single variable. Items of this nature were allocated, therefore, on the basis of the percentage relationship of peak-hour vehicle needs for each line to the system total.

Another cost item varying with number of vehicles is depreciation or rental charges for vehicles. The portion of depreciation or rental expense properly chargeable to a particular line is best measured by the percentage of the total fleet required to operate that line at the point in time when the system vehicle requirements are at the maximum.

A number of broad overhead expense items also were assigned to individual routes on the basis of peak-hour vehicle needs. The general office costs, including salaries of general office clerks and officials, as well as shop overhead expenses and similar items were handled in this manner, since these are not items which vary significantly with changes in volume of service.

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[2] There was one refinement of technique applied to the allocation of operators' wages on the AC system. The nature of transbay operations results in a considerably higher peak-to-base ratio than is the case with East Bay routes. The result of this higher ratio in some instances is a less efficient use of personnel and payment of higher guarantees or makeup allowances to men engaged in transbay operation. In order to take this into account, data were obtained from the AC Transit management indicating the number of pay hours in the aggregate for operating employees in transbay service and the corresponding total pay hours for East Bay lines. Total operators' wages were then subdivided on the basis of the pay hour relationship between the two classes of service and the two subtotals then allocated to individual transbay or East Bay lines on the basis of vehicle hours of service on each line.

Miles of Line. Certain operating expenses, particularly in electrically powered service, are basically a function of the number of route miles or length of the individual lines. Such costs include, for example, fences and signs, the cleaning and sanding of tracks and the maintenance of the signals, poles and fixtures. Also, routine inspection of roadway by track laborers falls under this heading, while the labor and material costs required to repair or replace rails, etc., are primarily related to use of the line in terms of miles of operation. Hence, track roadway labor was divided into two components, the construction and replacement function being allocated to individual lines on the basis of vehicle miles, while the routine inspection costs were assigned to lines on the basis of the miles of route.

Passenger Revenue. Operating costs resulting from claims expense and provision for accidents were assigned on the basis of the percentage relationship of line passenger revenue to the total for all routes in that class of service on Muni and in relation to the system total on AC Transit. Essentially, accident costs are a function of exposure and could therefore be allocated on vehicle miles or vehicle hours.

However, either of these bases could introduce some distortion so that passenger revenue is a better yardstick.[3]

Cost Allocation Formulas

In preparing the cost allocation model for cost projections under the integrated networks, two sets of adjustments were made in the fiscal 1965 figures for Muni and AC Transit. The first of these was to normalize base year costs in order to eliminate exceptional or non-recurring items. The second step was to update these normalized 1965 costs to reflect known changes for the 1967 fiscal year. No attempt was made to apply an inflation factor beyond operating costs in the current year on each system, despite the prevailing trend of wage and material costs. In this respect, costs and revenues are pegged at 1967 'constant dollar' levels, with appropriate escalation to be considered subsequently.

The cost formulas for the four classes of service operated by Muni were derived as follows:

Streetcar:

$$C = 6.328H + 0.31691M + 7{,}412V + 2{,}478L + 0.11792R$$

Cable Car:

$$C = 11.058H + 1.608M + 11{,}859V + 4{,}969L + 0.19624R$$

Trolley Coach:

$$C = 6.108H + 0.16978M + 7{,}000V + 404L + 0.09462R$$

Bus:

$$C = 6.359H + 0.15755M + 7{,}420V + 155L + 0.11456R$$

Where:

C = Average annual cost of operation
H = Vehicle hours
M = Vehicle miles
V = Vehicles required in peak morning or evening operation, whichever is higher
L = Length of line in miles
R = Route revenue in dollars

A similar analysis of AC Transit operating experience normalized and updated to 1967 fiscal year cost levels as previously described yielded the following formula:

Bus:

$$C = 6.209H + 0.11089M + 5{,}788V + 0.03865R$$

These formulas were used for analyzing current types of service operated by Muni and AC Transit, particularly in determining the margin between operating revenues and expenses for arterial routes, feeder lines, transbay routes, East Bay express and local lines, etc.

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[3] If vehicle miles were used as the foundation of allocating accident costs, it would mean that relatively fast lines which operate entirely or largely outside congested areas would bear a disproportionate share of accident expense. While vehicle hours would to some degree overcome this, passenger revenue is deemed to be a more appropriate base because it tends to reflect the extent of operation of the line in heavily congested areas. The routes which produce the largest volume of revenue are generally those which operate the largest portion of their service in populated areas; these also are those in which the traffic conditions are congested and in which accident exposure is most serious. Passenger revenue, of course, is a direct measure of exposure to claims for injury to passengers on the transit vehicles. Finally, where zoned fares are involved on lines of varying length, the use of passenger revenue reflects the variation in exposure resulting from greater length of route.

CHAPTER 7

Operating Results in 1965

FROM THE FARE BOX REVENUE standpoint, both of the major transit systems in the Bay Area had substantial deficits in fiscal 1965. Muni collected $19,904,816 in operating revenues and spent $27,966,377 to operate the service, leaving an aggregate net loss from operations of $8,061,561. Muni has been regularly running deficits in a range of five to 10 million dollars since 1960.

AC Transit's operating revenue, which includes passenger receipts and advertising, aggregated $13,363,691 in fiscal 1965. Cost of service in the same period totaled $14,827,112, resulting in a deficiency of $1,463,421. This system also has been managed as a deficit operation, with partial reliance on tax proceeds, since its conversion to a publicly-owned system in 1960.

Relationship of Revenues to Costs —Muni System

The total costs of operation on each of the four categories of Muni service—streetcars, cable cars, trolley coaches and buses—as apportioned to individual routes in accordance with formulas described in the prior chapter, revealed a substantial excess of expenses over revenues in fiscal 1965.

The amount by which aggregate costs exceeded operating revenues was approximately $1,000,000 on the streetcar lines, $920,000 on the cable cars, $1,500,000 on trolley coach routes and $4,640,000 on the bus operation (Table 26). In percentage terms, total costs were above operating revenues by 33% on streetcars, 78% on the cable cars, 22% on the trolley coaches, and 53% on the bus routes.

In the aggregate, the excess of total costs over operating revenues for all categories of service was more than eight million dollars.

Analysis of unit revenues and cost by route function—arterials, crosstown and feeder lines—indicated that the arterial routes had the most favorable revenue/cost relationship, followed by the crosstown lines and then the feeder operations. The loss per hour on Muni crosstown lines was about one-third larger than on arterial routes, while the hourly loss on feeder lines was more than twice as great as for arterial routes.

The Muni arterial routes as a group produced operating revenue of $.8005 per mile against costs aggregating $1.0849, or a loss of 28½¢ per mile. On an hourly basis, the deficit was $2.68 for each hour of service provided. The crosstown routes yielded a loss of nearly 38½¢ per mile and $3.57 per hour. The feeder and shuttle routes produced revenue of only 35¢ per mile as against costs totaling more than 94¢ per mile. The loss on feeder operations was 59¢ per mile and $5.51 per hour (Table 27).

For the Muni system as a whole, operating revenue per mile was 75.19¢ and the deficiency below total costs was 30.90¢ per mile. On an hourly basis, operating revenues aggregated $7.075 and the revenue deficiency was $2.908 for each hour of operation.

Relationship of Revenues to Costs —AC System

In order to get an overall measure of results, advertising and charter revenues have been apportioned among the various categories of AC Transit service and compared with the costs allocated in accordance with the formula described in the preceding chapter. The result reveals a profitable situation on transbay routes but indicates losses on all categories of East Bay service. The excess of revenues over total costs on the transbay lines was $670,000 (15%).

On East Bay arterial routes, there was a deficiency of $940,000 (14%), while crosstown lines failed to meet costs by about $245,000 (72%). The feeder operations of AC Transit lost well over $1,000,000, with costs being approximately 214% of operating revenues.

In total, East Bay operations had a deficiency in revenues of nearly $2,230,000, while the system as a whole had costs exceeding operating revenues by $1,463,000 (Table 28).

Since the AC Transit accounting system does not apportion other revenue (advertising, etc.) among individual lines, the detailed route analyses herein for AC Transit are confined to passenger revenue. Passenger revenue on transbay routes aggregated 68.86¢ per mile in fiscal 1965 as compared with total costs allocated to those routes of 62.31¢ per mile, indicating a net income of 6.55¢ per mile for the transbay service. Six of the 12 transbay lines operated in the black. In terms of operating results per hour, the 12 transbay lines yielded a profit of $1.24 for each hour of service (Table 29).

By contrast, only one of the 18 East Bay arterial lines operated on a profitable basis. The 18 lines as a group experienced a loss of 10.26¢ per mile and $1.26 for each hour of service.

All of the crosstown and feeder lines were loss operations. Taken together, the three crosstown routes produced 36.92¢ per mile in revenue and costs aggregated 65.85¢ per mile, yielding a loss of slightly less than 29¢ per mile. These routes lost $3.46 for each hour in service.

The feeder lines were heavy losers. Their revenue was less than 30¢ per mile as compared with costs of approximately 66½¢ per mile. The loss from these operations was 36.58¢ per mile, considerably greater than the aggregate revenue produced. On an hourly basis, the feeder lines yielded revenue of $3.72, as against costs totaling $8.28, or a loss of $4.56 for each hour of service.

USE OF TAX PROCEEDS TO AUGMENT REVENUES OF MUNI AND AC TRANSIT

The revenue/expense relationships on Bay Area transit systems described above reveal that both systems require non-transit funds to balance the scales. Subject to various restrictions and limitations, Muni and AC Transit have access to proceeds of taxation not alone for capital costs but for operating and maintenance expenses as well. The same is true for the BARTD operation.

The most striking development in transit in the last several years has been the unprecedented expansion of financial aid to local transportation systems from federal, state and local sources. There is now general recognition of the fact that transit is by far the most efficient means of circulation in a major urban area and that transit patronage ought to be encouraged by all practicable means. The Urban Mass Transportation Act of 1964 enacted by the Congress made available $375,000,000 in federal funds for the assistance of urban transit systems in the three-year period ending with fiscal 1967. In 1966, the Congress enlarged and extended this program of federal government aid to transit with the allocation of $150,000,000 annually for the fiscal years 1967, 1968 and 1969.

At the state level, there have been significant new developments making additional funds available for local transit needs. Massachusetts enacted a $225 million transit improvement program in 1964.

Legislation has been enacted in New York to consolidate the Transit Authority and the Triborough Bridge and Tunnel Authority, thus making available bridge and tunnel tolls to help defray transit costs in New York City. The City's transportation facilities will be financed through a common budget. A proposal has been put forward by the Regional Plan Association to add rush-hour surcharges for vehicles on bridges and tunnels and a surcharge on receipts of Manhattan parking lots and garages. The result would be to divert some auto riders to public transportation; those who continued to drive would be making a direct contribution to reduce the transit deficit.

In Pennsylvania, the administration has submitted a transit improvement and operating assistance program calling for expenditure of $300,000,000 in state funds over the next 10 years.

These developments on the federal and state level define the new direction of thinking throughout the country. Increasingly, it is being recognized that the supplementing of fare box revenue from general tax funds and other sources in order to encourage maximum patronage of public transportation is a sound community investment. Public policy as manifested by the action of government at all levels manifests a growing awareness of the value of good transit service, reasonably priced and supported where necessary by revenue from non-transit sources.

San Francisco Municipal Railway

Under the Charter of the City and County of San Francisco, the Public Utilities Commission is charged with responsibility for construction, management, supervision, maintenance, extension, operation and control of the San Francisco Municipal Railway. The Charter provides that in the event the Commission and the Mayor propose a budget for the Railway in which expenses will exceed projected revenues, such budget can be approved by a vote of two-thirds of all members of the Board of Supervisors. If this is done, the Board of Supervisors must also appropriate the funds necessary to provide for the deficiency.

For a number of years, it has been the policy of the City of San Francisco to meet a portion of the cost of the transit system from taxation, in order to maintain the 15¢ fare level and thus maximize the use of transit facilities. The deficits in recent fiscal years have been as follows:

1961	$5,979,830
1962	6,142,873
1963	6,817,729
1964	7,277,240
1965	7,991,711
1966	8,446,868

While deficits in meeting operating costs can be recovered from tax funds, there is a specific limitation in the Charter dealing with capital expenditures. Deficits incurred for additions, betterments, extensions or other capital costs can be taken care of in the same fashion as operating deficits provided the amount is not greater than three-quarters of one cent on each one hundred dollars valuation of property assessed in and subject to taxation by the City and County. This amounts to slightly more than $100,000, an amount which is grossly insufficient for Muni's capital needs. Whenever tax support is required for capital costs exceeding this, the Charter requires that such financing be accomplished by the sale of bonds and this requires submission of the question to the electorate. This means that any substantial purchase of new equipment for the Municipal Railway requires approval of a bond issue by the public. Two-thirds of the votes cast must be favorable in order for such a bond issue to be approved.

Muni has not been able to get sufficient popular support at the polls for new vehicles and buildings in 20 years, despite the fact that virtually its entire operating fleet is obsolete. The last attempt was made in November, 1966 when a $95½ million transit modernization program was voted upon. The issue received 58% public acceptance—not enough for its enactment. Even with respect to federal grants under the Urban Mass Transportation Act, Muni is in the anomalous position of not being able to raise its matching share by reason of this restrictive provision for public referendum.

AC Transit System

The Transit District Law grants authority to the Board of Directors to levy and collect

Table 26

RELATIONSHIP OF MUNI OPERATING REVENUES TO TOTAL COSTS
BY TYPE OF VEHICLE
Year Ended June 30, 1965

Type of Vehicle	Operating Revenue	Total Cost of Operations	Excess or (Deficiency) of Revenues Over Costs
Streetcar	$ 2,999,771	$ 3,997,778	$(998,007)
Cable Car	1,174,027	2,093,901	(919,874)
Trolley Coach	6,955,719	8,461,370	(1,505,651)
Motor Bus	8,775,298	13,413,327	(4,638,029)
TOTAL	$19,904,815	$27,996,377	$(8,061,561)

Table 28

RELATIONSHIP OF AC TRANSIT OPERATING REVENUES TO TOTAL COSTS
BY TYPE OF ROUTE
Year Ended June 30, 1965

Type of Route	Operating Revenue	Total Cost of Operations	Excess or (Deficiency) of Revenues Over Costs
Transbay	$ 5,244,262	$ 4,574,073	$ 670,189
East Bay Service			
Arterial	6,769,794	7,710,334	(940,540)
Crosstown	342,852	589,476	(246,624)
Feeder	911,171	1,953,229	(1,042,058)
Total - East Bay	$ 8,023,817	$10,253,039	$(2,229,222)
Interest Earned and Other Revenue	95,612	-	-
TOTAL	$13,363,691	$14,827,112	$(1,463,421)

taxes for any lawful purpose. Specifically, Article 8 of the enabling statute provides, in part, as follows: "If, in the opinion of the board, the revenues will not be sufficient for any and all lawful purposes, the board shall levy a tax for such purpose or purposes and fix the amount of money necessary to be raised therefor by taxation."

It has been the policy of the District since it took over operation of the former Key System in the fall of 1960 to seek to meet operating expenses from the fare box and to use tax proceeds only for capital requirements. However, expansion of service and rising unit costs, together with the desire to keep fares at a level which will encourage riding, has made it necessary for the District to draw increasingly upon tax proceeds. The supplementary amounts from taxation which AC Transit has received in each fiscal year have been as follows:

1961	$ 444,672
1962	455,165
1963	478,504
1964	1,980,926
1965	2,234,140
1966	2,344,783

In the first three years of operation, the District applied a tax rate of 2.9¢ per $100 of assessed valuation. In fiscal 1964, the rate was increased to 12.5¢ per $100, and in 1966 to 16.0¢.

Bay Area Rapid Transit District

The money to build the BARTD system is being obtained principally through general obligation bonds of the District and from revenues of the San Francisco-Oakland Bay Bridge. The Board of Directors has the power to levy taxes and must do so in order to collect each year the funds necessary to meet all sums coming due as principal, interest, and sinking fund requirements on its general obligation bonds.

BARTD also has taxing powers under the law which go beyond the requirements of its general obligation bonds. The enabling legislation permits taxes to be levied "for maintenance and operation of rapid transit facilities," adding that such levies "shall be supplementary to the revenues derived from such facilities and shall be limited to actual requirements." However, the rate for taxes levied in any fiscal year for all District purposes *other than* taxes levied to meet the general obligation bond principal, interest and sinking fund requirements "shall not exceed 5¢ on each $100 of assessed valuation of taxable property within the District."

Thus, while BARTD does have access to tax moneys for other than capital requirements, there is a specific limitation under existing legislation on the amount of tax funds available for operating and maintenance expenses. With assessed valuation approaching $5 billion at present, this source of supplementary funds for deficit operations would provide a maximum of $2½ million annually.

Table 27

MUNI ROUTE OPERATING RESULTS
Year Ended June 30, 1965

Route	Operating Results per Mile Operating Revenue	 Total Costs	 Margin per Mile	Operating Results per Hour Operating Revenue	 Total Costs	 Margin per Hour
			Arterial Routes			
38-Geary	$ .9697	$ .9804	$(.0107)	$9.2797	$ 9.3820	$(.1023)
30-Stockton (TC)	1.1163	1.1336	(.0173)	8.6101	8.7439	(.1338)
80-Leavenworth	1.1374	1.1854	(.0480)	8.5206	8.8801	(.3595)
45-Van Ness	1.0283	1.1689	(.1406)	8.2975	9.4320	(1.1345)
9-12-14-Mission Lines (TC)	.7887	.9144	(.1257)	7.6488	8.8670	(1.2182)
1-3-California-Jackson	.9313	1.1023	(.1710)	7.6389	9.0409	(1.4020)
8-Market	.9865	1.1914	(.2049)	7.1991	8.6943	(1.4952)
5-McAllister (TC)	.7566	.9139	(.1573)	7.3124	8.8326	(1.5202)
55-Sacramento	.9784	1.1676	(.1892)	8.3597	9.9764	(1.6167)
21-Hayes	.8760	1.0871	(.2111)	7.1197	8.8349	(1.7152)
47-Potrero	.8900	1.1711	(.2811)	6.3971	8.4175	(2.0204)
19-Polk	.9173	1.1811	(.2638)	7.0806	9.1167	(2.0361)
41-Union-Howard	9.0372	1.15768	(.25396)	7.4531	9.5475	(2.0944)
J-Church	1.0889	1.3557	(.2668)	8.9532	11.1466	(2.1934)
6-7-Haight-Masonic	.7941	1.0627	(.2686)	6.5292	8.7377	(2.2085)
31-Balboa	.7051	.9618	(.2567)	7.3681	10.0499	(2.6818)
N-Judah	.8529	1.1365	(.2836)	8.6759	11.5614	(2.8855)
KLM-Twin Peaks Lines	.8180	1.1113	(.2933)	8.6486	11.7487	(3.1001)
15-42-Third-Evans	.5765	.8487	(.2722)	6.7098	9.8787	(3.1689)
2-Clement	.6643	.7985	(.3142)	6.8941	10.1550	(3.2609)
11-14-Mission Lines (B)	.6715	.9879	(.3164)	6.9552	10.2320	(3.2768)
71-72 Sunset-Noriega	.5149	.8450	(.3301)	5.4731	8.9828	(3.5097)
25-Bryant	.4421	.7693	(.3272)	5.2768	9.1819	(3.9051)
33-Ashbury	.4887	.9310	(.4423)	4.4898	8.5536	(4.0638)
23-27-Crescent-Noe	.5089	.9476	(.4387)	4.7785	8.8997	(4.1212)
26-Valencia	.4487	.8219	(.3732)	5.0616	9.2715	(4.2099)
32-Embarcadero	.4898	.9405	(.4507)	4.9499	9.5085	(4.5586)
30-Stockton Express (B)	.5545	.9266	(.3721)	7.2940	12.1887	(4.8947)
66-Quintara	.3969	.9108	(.5139)	4.0351	9.2597	(5.2246)
5-McAllister (B)	.6245	1.2531	(.6286)	6.7204	13.4841	(6.7637)
17-Parkmerced	.3031	.7776	(.4745)	4.514	11.5830	(7.0676)
16-Noriega Express	.4634	1.0293	(.5659)	6.1866	13.7414	(7.5548)
59-60-Powell-Mason-Hyde	2.9168	4.9929	(2.0761)	13.2383	22.6608	(9.4225)
61-California	2.3145	4.8725	(2.5580)	11.8218	24.8873	(13.0655)
Total-Arterial Routes	$ .8005	$1.0849	$(.2844)	$ 7.5532	$10.2365	$(2.6833)

Table 27
(Continued)

	Operating Results per Mile			Operating Results per Hour		
Route	Operating Revenue	Total Costs	Margin per Mile	Operating Revenue	Total Costs	Margin per Hour
			Crosstown Routes			
22-Fillmore	$ .8704	$1.0910	$(.2206)	$6.4820	$ 8.1243	$(1.6423)
24-Divisadero	.6906	1.0585	(.3679)	5.7054	8.7452	(3.0398
35-Eureka	.5421	.9120	(.3699)	5.1416	8.6500	(3.5084)
10-Monterey	.4086	.8440	(.4354)	4.3788	9.0441	(4.6653)
43-Roosevelt	.3735	.9121	(.5386)	3.6821	8.9906	(5.3085)
28-19th Avenue	.3799	.8994	(.5195)	3.8934	9.2174	(5.3240)
18-Sloat	.2665	.7103	(.4438)	3.3852	9.0232	(5.6380)
Total-Crosstown Routes	$ .5524	$ .9366	$(.3842)	$5.1256	$ 8.6914	$(3.5658)
			Feeder or Shuttle Routes			
85-Downtown Shuttle	$ .9470	$1.2693	$(.3223)	$5.2560	$ 7.0450	$(1.7890)
86-Mission Shuttle	.2905	1.0383	(.7478)	1.9376	6.9247	(4.9871)
52-Excelsior	.4071	.9867	(.5796)	3.5843	8.6923	(5.1080)
53-Southern Heights	.3197	.8533	(.5366)	3.1768	8.5244	(5.3476)
51-Silver	.4158	.9635	(.5477)	4.2980	9.9592	(5.6612)
39-Coit	.2694	1.1850	(.9156)	1.7600	7.7380	(5.9780)
36-Miraloma	.2508	.8047	(.5539)	2.7561	8.8436	(6.0875)
37-Corbett	.2692	.8832	(.6140)	2.6759	8.7796	(6.1037)
34-Woodside	.3021	.8583	(.5562)	3.4167	9.7069	(6.2902)
29-Visitacion	.1563	.9399	(.7766)	1.4642	8.7416	(7.2774)
81-Bacon	.2068	.9586	(.7518)	2.0638	9.5665	(7.5027)
Total-Feeder or Shuttle Routes	$ .3509	$ .9432	$(.5923)	$3.2647	$ 8.7754	$(5.5107)
SYSTEM TOTAL	$ .7519	$1.0609	$(.3090)	$7.0754	$ 9.9838	$(2.9084)

( ) Indicates deficit.

(TC) Indicates trolley coach and (B) indicates bus where both types of vehicles are used on the same route.

Table 29

AC TRANSIT ROUTE OPERATING RESULTS
Year Ended June 30, 1965

Route	Operating Results per Mile			Operating Results per Hour		
	Passenger Revenue	Total Costs	Margin per Mile	Passenger Revenue	Total Costs	Margin per Hour
			Transbay Routes			
A-Oakland-12th Street	$1.0862	$.5421	$.5441	$18.94	$ 9.45	$9.49
F-Berkeley-Shattuck Avenue	.9251	.6428	.2823	15.88	11.03	4.85
B-Oakland-22nd Street	.7879	.6648	.1231	13.09	11.04	2.05
L-Richmond	.6850	.6044	.0806	13.98	12.33	1.65
C-Piedmont-40th Street	.7471	.6984	.0487	12.99	12.14	0.85
E-Claremont-55th Street	.6971	.6763	.0208	12.66	12.28	0.38
N-East Oakland-MacArthur Blvd.	.5974	.6276	(.0302)	12.04	12.65	(0.61)
K/R-Hayward	.5261	.5789	(.0523)	11.58	12.74	(1.16)
T-Treasure Island-Oakland	.4528	.5258	(.0730)	7.68	8.92	(1.24)
O/W-Encinal-Santa Clara Avenue	.5586	.6523	(.0937)	10.94	12.78	(1.84)
H-Berkeley-Sacramento Street	.6454	.7739	(.1285)	13.11	15.72	(2.61)
G-Thousand Oaks-Solano Avenue	.6571	.8229	(.1658)	12.92	16.18	(3.26)
Total-Transbay Routes	$ .6886	$.6231	$.0655	$13.12	$11.88	$1.24
			East Bay Arterial Routes			
51-Alameda-Oakland-Berkeley	$ .7348	$.7063	$.0285	$ 8.02	$ 7.71	$0.31
72-73-Oakland-Richmond	.6231	.6410	(.0179)	7.65	7.87	(0.22)
88-Albany-Market Street	.7124	.7449	(.0325)	7.21	7.53	(0.32)
80-1-2-3-Oakland-Hayward	.5759	.6013	(.0254)	7.88	8.22	(0.34)
40-1-3-Berkeley-East Oakland	.5946	.6516	(.0570)	7.32	8.02	(0.70)
33-Berkeley-Oakland Express	.5616	.6895	(.1279)	7.16	8.79	(1.63)
15-14th Avenue and MacArthur Blvd.	.5938	.7498	(.1560)	6.70	8.46	(1.76)
18-77-Park Blvd.-Lakeshore-Piedmont Pines	.5361	.7344	(.1983)	5.81	7.96	(2.15)
34-MacArthur Boulevard-Express	.5009	.6882	(.1873)	6.59	9.07	(2.48)
12-Grand Avenue-West 14th Street	.4529	.7193	(.2664)	4.76	7.56	(2.80)
42-Naval Air Station-Piedmont	.4448	.7122	(.2674)	4.97	7.96	(2.99)
14-Brookdale Avenue	.4056	.7159	(.3103)	4.53	8.00	(3.47)
11-Oakland Avenue	.4097	.8584	(.4487)	3.63	7.60	(3.97)
30-32-Hayward Express	.3189	.5368	(.2179)	6.12	10.31	(4.19)
59-76-Broadway Terrace-Montclair	.3910	.8208	(.4298)	4.00	8.39	(4.39)
36-Washington Manor Express	.3383	.6153	(.2770)	5.89	10.72	(4.83)
31-Richmond-Oakland Express	.3470	.6776	(.3306)	6.30	12.47	(6.17)
38-San Leandro-Bancroft-Oakland	.3196	.7491	(.4295)	4.64	10.87	(6.23)
Total - Arterial Routes	$.5652	$.6678	$(.1026)	$ 6.93	$ 8.19	$(1.26)

Table 29
(Continued)

Route	Operating Results per Mile			Operating Results per Hour		
	Passenger Revenue	Total Costs	Margin per Mile	Passenger Revenue	Total Costs	Margin per Hour
			Crosstown Routes			
57-MacArthur Boulevard	$.3867	$.6340	$(.2473)	$4.84	$ 7.93	$(3.09)
64-San Jose Avenue	.4087	.7375	(.3288)	4.36	7.87	(3.51)
79-High Street	.2194	.6336	(.4142)	2.65	7.66	(5.01)
Total — Crosstown Routes	$.3692	$.6585	$(.2893)	$4.42	$ 7.88	$(3.46)
			Feeder Routes			
94-Golden Gate Field	$.8989	$.9038	$(.0049)	$6.11	$ 6.15	$(0.04)
53-Fruitvale Avenue	.4580	.7999	(.3419)	4.23	7.39	(3.16)
54-35th - 38th Avenues	.3621	.6718	(.3097)	4.12	7.65	(3.53)
69-23rd Street	.3781	.6576	(.2795)	4.82	8.38	(3.56)
56-Seminary Avenue	.3003	.6150	(.3147)	4.03	8.25	(4.22)
7-75-Arlington-Euclid	.3132	.6312	(.3180)	4.20	8.46	(4.26)
78-Carlson Blvd.-13th Street	.2692	.5903	(.3211)	3.58	7.85	(4.27)
67-Spruce Street	.2732	.6251	(.3519)	3.44	7.87	(4.43)
93-San Lorenzo-Bay Fair-Fairmont Hospital	.2472	.5776	(.3304)	3.60	8.42	(4.82)
65-Dwight Way	.3339	.8222	(.4883)	3.33	8.21	(4.88)
68-Barrett Avenue	.2547	.6694	(.4147)	3.14	8.25	(5.11)
91-Castro Valley-Hayward	.2762	.6674	(.3912)	3.62	8.74	(5.12)
74-Ashby Avenue	.2861	.7772	(.4911)	3.09	8.38	(5.29)
63-S. Shore-Park Street-Farm Island	.1806	.5950	(.4144)	2.36	7.78	(5.42)
55-Dulton Avenue	.2050	.6551	(.4501)	2.68	8.56	(5.88)
46-87-Arthur-Olive St.-Kingsland-Maxwell	.1906	.8291	(.6385)	1.78	7.73	(5.95)
90-92-Hayward-Palma Ceia	.3046	.7592	(.4546)	4.09	10.21	(6.12)
66-Youell Field	.4672	1.9934	(1.5262)	2.00	8.53	(6.53)
17-Alcatraz-College Avenue	.1707	.9084	(.7377)	1.62	8.64	(7.02)
Total-Feeder Routes	$.2989	$.6647	$(.3658)	$3.72	$ 8.28	$(4.56)
SYSTEM TOTAL	$.5629	$.6526	$(.0897)	$7.81	$ 9.05	$(1.24)

( ) Indicates deficit.

CHAPTER 8

Travel Relationships

THE TRANSIT INDUSTRY has long recognized the factors which affect use of its service in urban areas. Formulas for expressing the impact of fare increase upon transit patronage, for example, are in regular use. Federally sponsored projects have demonstrated and quantified the relationship between service and ridership of which management has had an innate awareness: as service is cut, ridership drops and, conversely, as mileage is increased, ridership rises.

These variables have the common characteristic of being related entirely to the transit system. In addition, there are variables known to affect transit use, outside the purview of management. These relate to the characteristics of transit patrons and land use.

Rider characteristics include the diversity of socio-economic factors pertaining to the needs and aspirations of people in moving from place to place. With rising income, people have expressed their desire for higher living standards by seeking more living space, higher speed, greater comfort and convenience, even when these involve higher costs. Advancing living standards have created increasing auto usage with a matching decline in transit riding over the past two decades. Transportation studies of metropolitan areas across the country show that local gains in personal income have been more significant in explaining the decline of transit usage than deteriorating service.

The third group of factors affecting transit riding involves land use characteristics. Each land activity—central city commercial, residential, industrial, etc.—generates or attracts traffic flow of a particular nature and magnitude. The P.M. rush hour outpouring from downtown offices is an illustration. Instead of studying this traffic flow itself, the planners' attention is directed to the land use giving rise to that flow in relation to the purpose for which trips are made, i.e., work, shopping, social-recreation, school, etc.

It is only in recent years that transportation planners have developed measures for expressing such factors as residential density, average family income, auto ownership and shopping trips in relation to one another. Areawide transportation studies have promoted the assembling of this information and processing it with high-speed electronic computers, thus forming the basis for auto and transit trip patterns.

Applying this approach to the San Francisco Bay Area, the factors affecting choice of travel were grouped into three broad categories:

1. *Rider Characteristics*
   a. Transit route locations
   b. Auto ownership and availability
   c. Family income

2. *System Characteristics*
   a. Transit route locations
   b. Location of highway facilities
   c. Operating speeds—auto and transit
   d. Transit headways at various periods of day
   e. Directness of transit routing
   f. Point-to-point travel times by transit and auto systems
   g. Quantity of transit service

3. *Land Use Characteristics*
   a. Residential density
   b. Employment density
   c. Commercial activity
   d. Population

The initial task was to develop reliable measures for each of these variables, preliminary to drawing correlations between them and segregating those having a significant measurable effect on transit usage.

Calculating Transit Use

Research conducted by NCTDP evaluated many combinations of variables which affect transit use in an attempt to quantify relationships and develop a set of estimating equations. The resultant models drew together the combined effects of the several categories and enabled the calculation of future transit trips within prescribed limits of planning accuracy. An extensive list of 52 variables which could be applied to the transit use estimating problem was collected and calculated for each of the 474 zones in the study area. High-speed computers were used to analyze this initial list of more than 41,000 "pieces of data." This first test, to investigate and "screen" the variables worthy of additional analysis, would have required more than four man-years had it been done by hand.

Some variables were then discarded because of problems in making accurate measurement, inability to predict them with confidence or very low correlation with transit use. The remaining variables were subjected to further analysis.

Transit Plan Evaluation

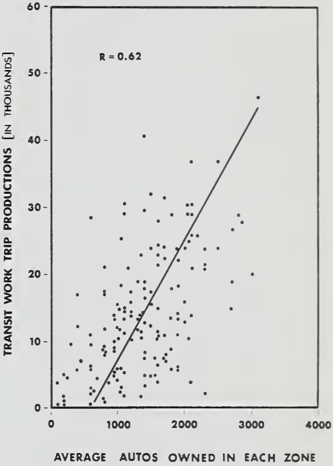
The effects of changes in any of the pertinent variables upon transit use were determined by relating transit use, mathematically, to the factors which cause transit travel—characteristics of land use, the transit rider, and the transit system. For example, a system variable, such as travel time to the San Francisco CBD, might change by speeding up transit service, through new facilities or modification of present service; resulting changes in transit were then measured.

System-related variables were measured through the use of computer analysis of coded transit networks. This technique generally involved the subdivision of each transit route into a series of "travel links" defined to the computer by a set of "node numbers" at each end of the link. Information was provided to the machine for the distance, travel time and speed of each link in the system. In addition to travel on transit routes, coded links were also inserted for access to and from each of the 474 zone centroids and for transfers required between transit routes.

FIGURE 23

SIMPLE CORRELATION
TRANSIT WORK TRIP PRODUCTIONS
AND AUTO OWNERSHIP

SAN FRANCISCO ZONES



Several combinations of land-use changes with alternative transit networks permitted an evaluation of the combined effects of modified transit service, growth in area population, and the continued trend toward higher auto ownership rates.

The mathematical expression which combines and quantifies these factors—the transit use model—was the basic tool for evaluating the results of altering the framework within which the present transportation network operates.

MULTIPLE REGRESSION ANALYSIS

To draw correlations among this large number of variables, NCTDP used high-speed electronic computers and stepwise multiple regression analysis. Essentially, the computer program (BMD 02R) employed standard statistical procedures to calculate the degree of correlation of each variable with every other variable.[1]

This analysis technique may be visualized by examining the relationship between San Francisco transit work trip productions per zone and the total autos owned in each zone shown on Figure 23. This chart shows points for each of the 172 San Francisco zones plotted to reflect the total autos owned and work trips produced in each zone. The scatter of points indicates an imperfect relationship between these two variables. The questions to be answered by the regression analysis are: how 'imperfect' is the relationship, and can a straight line graph be found which best fits these points? Figure 23 illustrates this "line of best fit" and the resulting degree of correlation; this set of data yields a "coefficient of correlation" of 0.62 indicating that approximately 38% (the correlation coefficient squared) of the variation in work trips produced in San Francisco zones is attributable to the auto ownership of the zone. Obviously, with this limited simple correlation, there must be other factors which can be combined with auto ownership to better describe the number of work trips.

This example illustrates the technique which was used on each of the many variables: first, correlating them singly with each type of transit trip and secondly, in multiple groups to optimize the degree of correlation. (Table 30 shows correlations of other variables with work trips.)

Stepwise Analysis

The combination of several simple correlations into an equation with an improved degree of correlation constitutes the formation of an "estimating model." The method employed in the determination of these estimating equations, or models, involved the calculation of simple correlation coefficients among all of the independent and dependent variables, as previously explained, with subsequent selection of a combination of variables to make up the estimating model.

Independent variables when taken in combination with each other must improve the overall correlation coefficient as additional variables are brought into the relationship. However, only those variables which significantly contribute to the total correlation warrant inclusion in the estimating models. The amount of additional variation a particular variable adds to the total relationship is measured through the use of statistical tests.

Table 30

CORRELATIONS OF SEVERAL VARIABLES WITH WORK TRIPS

Variables Correlated with Work Trip Productions	Coefficient of Correlation
Number of autos per acre	0.654
Autos owned in each zone	0.617
Number of employed persons x housing units with no auto	0.638
Zone population per acre	0.542
Housing units with no autos	0.537
Employed persons per bus seat passing through the zone	0.486
Travel time ratio to San Francisco CBD Transit/Auto	0.417
Variables Correlated with Work Trip Attractions	
Employment per acre	0.924
Number of bus miles of service per acre	0.689
Average daily seats passing through zone	0.551
Average daily buses through the zone	0.501

---

[1] The coefficient of correlation is the statistical measure calculated to represent the degree of variation in one variable attributable to another variable. This coefficient ranges from 0.0 (no correlation between the variables) to 1.0 (perfect correlation between the variables). Although it is difficult to generalize about this statistical measure, it may be said that coefficients of correlation higher than 0.8 indicate a very good relationship between two variables—coefficients between 0.5 and 0.8 indicate good but not quite as significant relationships. Normally, relationships with coefficients of correlation less than 0.5 are used only when no other estimating technique is available.

When only two variables are involved in an estimating equation, the analysis is referred to as simple regression. When more than two variables enter into a relationship, the problem becomes one of multiple regression.

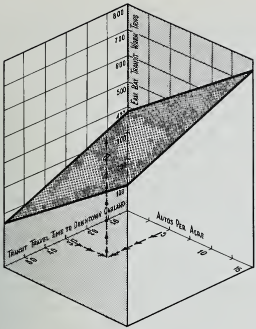

800
700
600
500
400
300
200
100
East Bay Transit Work Trips
Transit Travel Time to Downtown Oakland
50
40
30
20
10
Autos Per Acre
5
10
15

FIGURE 24

TRANSIT TRIP "SURFACE"

WORK TRIPS RELATED TO TRAVEL TIME AND AUTOS/ACRE

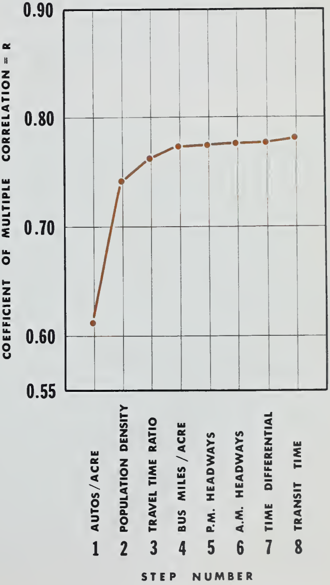
The stepwise procedure used in model development for the NCTDP area operates in this way, ranking the independent variables by the amount of variation they explain, then adding each variable into the estimating equation in a stepwise fashion.

A "three-variable" relationship is graphically illustrated in Figure 24—the automobile density in East Bay zones, the transit travel time to downtown Oakland and the number of work trips produced from East Bay zones. This relationship, instead of resulting in a straight line graph, develops a plane surface in three dimensions. The example shows that for an automobile density of five autos per acre and a transit travel time to downtown Oakland of 30 minutes, a zone will produce 400 transit trips. However, if the automobile density is held constant at five and the travel time is increased to 50 minutes, the number of transit trips drops to 310.

Relationships involving more than three variables cannot, of course, be plotted. However, the procedure can be extended to include as many variables as contribute to the statistical significance of the relationship. The extension of the simple correlation example illustrated for San Francisco work trips to a "multiple" analysis is depicted in Figure 25. At the completion of Step 1, the program selected auto ownership with a correlation of 0.62. The effect on the degree of correlation by addition of subsequent variables is evident in succeeding steps—at the completion of Step 2, the degree of correlation has been increased from 0.62 to 0.74. As the analysis progresses from this step, and additional variables are drawn into the relationship, "diminishing returns" set in: Step 3 yields 0.76 and Step 4 increases to 0.78. Beyond Step 5, little is added to the estimating accuracy of the equation by considering more variables.

FIGURE 25

STEPWISE REGRESSION ANALYSIS SAN FRANCISCO WORK PRODUCTIONS



TRANSIT USE MODEL

The estimating technique developed for the NCTDP study differs from modal split models in its basic concept, for it did *not* estimate "modal split." The dependent variable for the NCTDP estimating method was not percent transit trips of total trips but the number of transit trips generated in each zone.

The modal split methodology generally used in areawide transportation studies develops the total travel market by calibrating trip generation of total person trips. As a later step in the process, relationships are developed which "split" this total market into transit and auto segments. An underlying concept of this method is that once a trip is generated (usually based on variables such as persons per dwelling unit, auto ownership, family income and others) it is made on either the highway system or the transit system depending upon the characteristics of the trip and the systems. The total pool of trips remains the same regardless of what type of transit system is planned—only the modal split changes.

Generating each segment of the travel market independently (the NCTDP approach) also involved the use of explanatory variables which measured the characteristics of the tripmakers, land uses, the highway system and the transit system being tested. In this method, however, not only did the split between transit and auto vary among the test systems but the total pool of trips varied as well.

This is a significant factor in areas of low auto ownership where the method of generating total trips would yield relatively few trips and "split" most of these onto transit because of the low auto ownership. This type of area usually has high density and very convenient transit service (because of its density and lack of autos) and trips from these sections—especially midday shopping and miscellaneous travel—are made or not according to the existence of transit service.

The usual modal split technique is not sensitive to this type of distinction and would tend to underestimate transit use. Conversely, for "home-to-work" travel in areas of average income, high auto ownership and poor transit

Table 31

FACTORS AFFECTING TRANSIT TRAVEL IN SAN FRANCISCO
RANKED BY IMPORTANCE (a)

	Transit Trip Type		
Zone Variable	Home-based Work	Home-based Non-Work	Non-Home-based
Total Autos Owned	1	2	12
Autos per Acre	2	1	8
Population	3	3	10
Travel Time Ratio to SF CBD (b)	4	5	7
Travel Time Difference to SF CBD	5	6	5
Population per Acre	6	4	9
Median Income	7	9	11
Bus-miles of Service per Acre	8	7	1
Daily Number of Transit Seats Provided	9	8	2
Peak Transit Headways	10	11	6
Off-peak Transit Headways	11	12	4
Bus-miles of Service	12	10	3

(a) In sequence by coefficient of correlation between variables and transit trip type.
(b) Transit travel time to downtown San Francisco divided by corresponding auto travel time.

service, the normal modal split method probably yields satisfactory estimates of transit use.

This hypothesis was tested in preliminary research performed prior to formulation of the actual estimating procedure by NCTDP. Tables 31 and 32 list the variables found to be significant in estimating transit trips by the order of their importance for work, non-work and non-home-based convenience travel. Work travel is related to normal variables in a reasonable sequence—auto ownership, population and relative travel time. Non-home-based travel, however, is not primarily influenced by these variables, but is significantly affected by the "service" variables such as the number of bus miles per acre of zone (a measure of service density), the number of transit seats provided over a service day and the *off-peak* headways through the zone.

This is an indication that the latter type of travel is principally a function of the quantity of service. The question is not whether to make the trip by auto or transit—it is whether to make it at all.

The statistical validity of the transit O-D study resulting from the high sample rate, enabled NCTDP to develop transit estimating equations which predicted transit trips directly rather than as a percentage of total travel.

FINAL ESTIMATING EQUATIONS

Preliminary multiple regression analysis indicated a significant difference in the characteristics of transit travel, not only for the several trip purpose categories tested, but also between zones in San Francisco and between those in the East Bay and peninsula areas. Stratification of the data between San Francisco and the remainder of the study area was the result of preliminary correlation which showed significant differences in transit use characteristics. Compared with the rest of the Bay Area, San Francisco's residential density ranges from four to six times higher, its median income is significantly less and its auto ownership rates per dwelling unit are 30-40% lower. In addition, transit usage in San Francisco has certain peculiar, albeit, explainable, characteristics—median income which usually has a significant effect on transit use had no correlation in San Francisco, since many of the wealthiest areas are in the highest density sections around Nob Hill.

Table 32

FACTORS AFFECTING TRANSIT TRAVEL IN THE EAST BAY
RANKED BY IMPORTANCE (a)

Zone Variable	Transit Trip Type		
	Home-based Work	Home-based Non-Work	Non-Home-based
Travel Time Difference to SF CBD	1	3	6
Travel Time Difference to Oakland CBD	2	1	3
Autos per Acre	3	2	13
Peak Transit Headways	4	7	8
Travel Time Ratio to SF CBD (b)	5	9	10
Off-Peak Transit Headways	6	5	7
Daily Number of Transit seats Provided	7	6	1
Total Autos Owned	8	12	9
Population per Acre	9	4	12
Bus-miles of Service	10	13	4
Bus-miles of Service per Acre	11	8	2
Travel Time Ratio to Oakland CBD	12	11	11
Median Income	13	12	5

(a) In sequence by coefficient of correlation between variables and transit trip type

(b) Transit travel time to downtown San Francisco divided by corresponding auto travel time.

This stratification and the combination of trip purposes into three basic categories, (home-based work, home-based non-work, and non-home-based), resulted in the formulation of 12 transit trip estimating equations—three trip purpose categories each for trip productions and attractions, separated between San Francisco and "remainder Bay Area."

The 12 equations used for estimating transit trip productions and attractions were developed with the following independent variables and their combinations:

1. Population
2. Employment
3. Automobiles owned
4. Gross population density
5. Median family income
6. Weekday miles of transit service
7. Service density measured by transit miles per acre
8. Transit travel time from each zone to downtown Oakland and downtown San Francisco
9. Auto travel time from each zone to downtown Oakland and downtown San Francisco
10. Composite peak hour headways in minutes
11. Composite off-peak hour headways in minutes
12. Employment density in jobs per acre
13. Number of transit seats on weekday schedule

Table 33 lists the final estimating equations for each trip purpose. The maximum number of variables used in any equation are the seven variables used to estimate East Bay home-based work trip productions.

Table 33

NCTDP TRANSIT TRIP ESTIMATING EQUATIONS

EQUATION 1—San Francisco Home-based Work Trip Productions

Y = + 301.10 + 0.19 Population + 128.74 Cars/Acre + 112.40 Transit Miles/Acre — 331.93 Transit Time/Auto Time — 18.01 Population/Acre

EQUATION 2—San Francisco Home-based Non-work Trip Productions

Y = — 37.50 + 0.06 Population — 0.12 Base Headways + 31.33 Autos/Acre + 35.08 Transit Miles/Acre — 4.15 Population/Acre

EQUATION 3—San Francisco Non-home-based Trip Productions

Y = + 267.33 + 0.03 Population — 6.85 Transit Time + 82.52 Transit Miles/Acre — 2.30 Population/Acre

EQUATION 4—San Francisco Home-based Work Trip Attractions

Y = — 203.43 + 2.48 Seats Provided + 0.11 Employment

EQUATION 5—San Francisco Home-based Non-work Trip Attractions

Y = + 82.83 + 88.31 Transit Miles/Acre

EQUATION 6—San Francisco Non-home-based Trip Attractions

Y = — 42.21 + 0.69 Seats Provided + 2.73 Population/Acre

EQUATION 7—East Bay Home-based Work Trip Productions

Y = + 648.41 + 0.02 Median Income — 0.08 A.M. Headway — 15.16 Transit Time Oakland CBD + 15.67 Time Differential Oakland CBD + 60.38 Autos/Acre — 114.26 Time Ratio San Francisco CBD — 15.93 Population/Acre

EQUATION 8—East Bay Home-based Non-work Trip Productions

Y = + 106.66 — 0.02 Base Headway — 1.65 Transit Time Oakland CBD + 22.82 Time Ratio Oakland CBD + 6.61 Autos/Acre

EQUATION 9—East Bay Non-home-based Trip Productions

Y = + 93.90 — 0.003 Median Income — 0.01 Base Headway — 0.54 Transit Time, Oakland CBD + 6.69 Transit Miles/Acre + 0.93 Employment/Acre — 0.50 Population/Acre

EQUATION 10—East Bay Home-based Work Trip Attractions

Y = — 67.95 + 0.35 Seats Provided + 34.00 Employment/Acre

EQUATION 11—East Bay Home-based Non-Work Trip Attractions

Y = — 17.31 + 0.21 Seats Provided + 11.78 Employment/Acre

EQUATION 12—East Bay Non-home-based Trip Attractions

Y = — 15.16 + 0.08 Seats Provided + 5.88 Employment/Acre

TRIP DISTRIBUTION MODEL

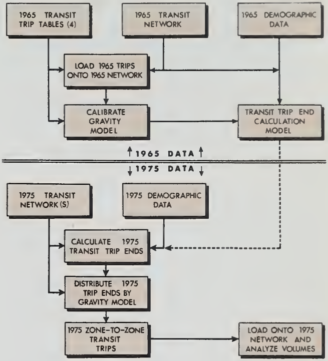
The techniques described in the forepart of this chapter were concerned with the calculation of the total transit trips produced in any study area zone and the total transit trips attracted to that zone. The second phase of the traffic estimation process involved the distribution of trips *between* zones of trip production and attraction.

As in the trip estimation process, careful analysis was made of the factors which cause current travel between specific sectors of the urban area so that the resulting relationships would be usable for future estimates. Models of this type must be capable of responding to the changes in the urban transportation network which cause shifts in the major corridors of travel.

Research conducted for a number of years has developed the so-called "gravity model," which derives its name from the similarity of its concepts with the gravitational formulas developed by Newton. The gravity model is relatively simple in concept; it essentially says that trip interchange between any pair of zones is directly dependent upon the relative attraction of each of the zones and varies inversely as a function of the spatial separation between them. The expression of spatial separation (usually defined as a function of the travel time between the pair of zones under consideration) changes the relative attraction of each zone for the desire of the trip maker to overcome this "spatial resistance."

FIGURE 26

TRANSIT TRAVEL ESTIMATING PROCESS


1965 TRANSIT TRIP TABLES (4)
1965 TRANSIT NETWORK
1965 DEMOGRAPHIC DATA
LOAD 1965 TRIPS ONTO 1965 NETWORK
CALIBRATE GRAVITY MODEL
TRANSIT TRIP END CALCULATION MODEL
1965 DATA
1975 DATA
1975 TRANSIT NETWORK (S)
1975 DEMOGRAPHIC DATA
CALCULATE 1975 TRANSIT TRIP ENDS
DISTRIBUTE 1975 TRIP ENDS BY GRAVITY MODEL
1975 ZONE-TO-ZONE TRANSIT TRIPS
LOAD ONTO 1975 NETWORK AND ANALYZE VOLUMES

Derivation of Input

Before using the gravity model to calculate the future trip distribution pattern, it was necessary to calibrate the 'travel-time factors' so that the formula was capable of accurately reproducing the current trip distribution pattern.

One of the earliest uses of the gravity concept was in connection with retail marketing studies in the middle 1930's. W. J. Reilly observed that two cities attract retail trade from an intermediate city approximately in direct proportion to the population of the two cities and in inverse proportion to the square of the distance from these two cities to the intermediate city.[2] Out of this early work grew the "P_1P_2/D" hypothesis.

Intervening research has developed the revised formula shown below—the concept is unchanged but the ingredients differ substantially:

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[2] *The Law of Retail Gravitation*, Filsburg, New York, 1953.

$$T_{i-j} = \frac{P_i \; A_j \; F(t_{i-j})}{\sum_{x=1}^{n} A_x \; F(t_{i-x})}$$

Where:

T_{i-j} = trips produced in zone i and attracted to zone j.

P_i = trips produced by zone i.

A_j = trips attracted by zone j.

$F(t_{i-j})$ = empirically derived travel time factor which expresses the average areawide effect of spatial separation on trip interchange between zones which are t_{i-j} apart.

Table 34
DOWNTOWN OAKLAND CORDON COUNT COMPARISON
AC Transit Adult Passenger Counts vs. 1965 Network Data

CBD Sector	Average Weekday in 1965 AC Count Data	Average Weekday in 1965 Network Link Data	Percent Error
14th St. Corridor (South of CBD)	53,420	53,239	—0.4%
Broadway Corridor (North and East of CBD)	58,348	57,057	—2.2
TOTAL	111,768	110,296	—1.3%

The trips produced in or attracted to any zone had been determined by the postcard survey conducted by NCTDP.[3] Travel times over the current transit system between pairs of zones were developed in the coded transit network.[4]

With these data available, the gravity model was calibrated for each of the trip purposes involved in the analysis. The first phase of the calibration involved matching of the actual and calculated trip length distributions. For this purpose, the frequency distributions (Figure 16, Chapter 3) were the criteria against which the performance of the model was measured. Travel time "F" factors for use in the model were derived by a trial and error or "calibration" process to arrive at a quantitative measure of the effect of time on tripmaking.

Accuracy Checks

As previously pointed out, an underlying consideration of the systems analysis procedures employed in the NCTDP program is that the techniques developed for the estimation of future travel are first tested for their ability to reproduce present-day travel as it occurs "on the street." The network coding procedures and calculation of 'minimum travel paths'[5] provide the tools for determining the volume of travel on every segment of the network under consideration for any set of demographic circumstances.

By assigning 1965 estimated travel as developed through the origin-destination survey to a 1965 route network which simulates the existing transit system, it was possible to 'pick off' travel volumes at points corresponding to maximum load point volumes regularly counted by the transit operating company.

Table 34 summarizes a comparison of the downtown Oakland cordon count made by AC Transit at maximum load points around the Oakland CBD and estimated volumes read from the 1965 simulation network. Both sets of data were selected route-by-route and summarized for ease of comparison. The overall difference in the downtown cordon, appearing on Table 34, shows the network link data 1.3% less than the AC Transit cordon count. This difference is well within reasonable limits of planning accuracy; in fact, it exceeds the accuracy limitations of the origin-destination survey and that of the cordon count itself.

Similar count comparisons for AC Transit transbay routes yield network link volumes within 2% accuracy of bridge toll booth counts.

Further comparisons were made between Muni maximum load points around the San Francisco CBD and estimated volumes read from the 1965 simulation network. The overall difference in this downtown cordon, as indicated on Table 35, shows the network link data 0.04% more than the Muni cordon count. With this closeness at various screenlines throughout the system, the model was sufficiently finetuned for route planning.

Table 35
DOWNTOWN SAN FRANCISCO CORDON COUNT COMPARISON
Muni Adult Passenger Counts vs. 1965 Network Data

CBD Sector	Average Weekday in 1965 Muni Count Data	Average Weekday in 1965 Network Link Data	Percent Error
North Beach Corridor (North of CBD)	66,544	65,764	— 1.2%
Richmond-Twin Peaks Corridor (West of CBD)	155,299	154,452	— 0.5
Bayview-Mission Corridor (South of CBD)	58,259	60,020	+ 3.0
TOTAL	280,102	280,236	+ 0.04%

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[3] Simpson & Curtin, *Technical Memorandum No. 11: Characteristics of Bay Area Transit Riders in 1965*, September, 1965.

[4] Simpson & Curtin, *Technical Memorandum No. 13: Estimating Future Transit Use*, February, 1966.

[5] *Ibid.*

CHAPTER 9

Population and Economic Growth

THE VIGOR with which the Bay Area continues to grow provides the substance upon which future estimates of transit usage are founded—anticipated people and jobs in 1975. With nearly three million people, the San Francisco-Oakland metropolitan area is the nation's seventh largest population center, ranking behind New York, Los Angeles, Chicago, Philadelphia, Detroit and Boston.[1] More significantly, this is one of the fastest growing among the top 10 metropolitan areas in the country.

The growth rate in the Bay Area for the 1960-1964 period slightly exceeds the growth rate for the 1950-1960 decade—only Washington, D.C. and New York share this distinction of having increased their growth rates in the years following the 1960 census.

1975 Bay Area Population

The NCTDP study area population is estimated to increase 20% by 1975. This increase will occur primarily in the less maturely developed areas of the East Bay. San Francisco is expected to increase 4% in the decade 1965-1975 (Figure 27).

The bulk of this growth will be clustered around the extremities of the planned BARTD line in the Concord-Pleasant Hill-Walnut Creek area on the east and the Fremont area to the south (Figure 28 shows a dot for every 10 new residents in 1965-1975). Similar increases are anticipated in the rapidly developing sections of San Mateo County.

Older sections of Oakland, Richmond and San Francisco have achieved a degree of population stability and therefore will have a lesser growth rate.

Projection Techniques

This analysis relies heavily on the data bank of planning information collected and analyzed by state, county and local planning agencies in the NCTDP study area. These groups cooperated in the provision of data which formed the basis of population and employment projections by NCTDP. Feedback relationship was established with these agencies for review of NCTDP zonal projections of population and employment by the respective planning agencies—suggested changes were incorporated in the final projections.

In cases where it was necessary for NCTDP to produce independent population projections, two basic methods were employed: (a) the trend line method, which examines past trends and projects them (or modifications of them) into the future; (b) the step-down ratio method, which projects the population of relatively small geographic areas as a ratio of a predetermined projection for a larger statistical area. Where independent employment projections were necessary, these two methods were used, supplemented by component (or sector) analysis by which different components of total employment are projected separately.

Population Projections for San Francisco

Results of the 1960 census indicated that the population of San Francisco declined in the 1950-1960 decade from 775,000 to 740,000—a 4.5% drop. Estimates of 1965 population have ranged from a low of 719,000 to a high of 769,000. As a base for NCTDP projections, the California State Department of Finance 1965 estimate of 755,000 persons was selected as a reasonably conservative figure, representing a rise of 15,000 persons or 2% over the 1960 census population.

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[1] Bureau of the Census, U.S. Department of Commerce, *Americans at Mid-Decade*, Series P-23, No. 16, January, 1966.

Projections of the city's population to 1975—completed prior to publication of the 1960 census data—appear to be outdated by trends disclosed in the census. In 1959, the San Francisco Planning Department projected a 1975 population of 906,000. At the same time, the United States Army Corps of Engineers published a 1975 population estimate of 825,000. After the 1960 census, projections of the city's population made by various agencies were much more conservative. In 1962, BARTD and the State Department of Finance published 1975 projections of 750,000 persons and 762,000 persons respectively. Therefore, in this three-year period, four responsible planning agencies made separate projections of the 1975 population for San Francisco ranging from 750,000 to 906,000—a spread of 21%.

After evaluating these past projection efforts, the Community Renewal Program recently proposed for the city and the relatively modest increase in the 1960-1965 period, NCTDP has projected the population of San Francisco to reach 785,000 by 1975.

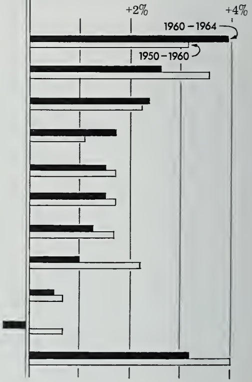
While the success of San Francisco's Community Renewal Program cannot be predicted, its goal of reducing the outflow of city families to surrounding counties should be recognized. This vigorous CRP, coupled with the improvements in accessibility created by rapid transit development, should enable the city to at least sustain the modest growth rates which have been in evidence since 1960.

Table 36

TEN LARGEST METROPOLITAN AREAS
Ranked by Percent Change in Population: 1960 - 1964

Area	Rank by Size	1964 Population (Millions)
Washington, D.C.	9	2.3
Los Angeles - Long Beach, California	2	6.7
SAN FRANCISCO - OAKLAND, CALIF.	7	2.9
New York, New York	1	11.3
Philadelphia, Pa.	4	4.6
Chicago, Illinois	3	6.6
St. Louis, Missouri	10	2.2
Detroit, Michigan	5	3.9
Boston, Massachusetts	6	3.2
Pittsburgh, Pennsylvania	8	2.4
CALIFORNIA		18.6

Average Annual Percent Change



SOURCE: Bureau of the Census, Current Population Reports, Series P-25, Nos. 298, 308, and 312.

Travel Zone Distribution

The city-wide population projection for San Francisco was distributed among 172 zones through consideration of the following elements:

(a) Past census tract trends from 1950;
(b) Present intensity of development measured in the City Planning Department's land use data;
(c) The holding capacity as a function of vacant land and the provisions of the city's master plan;
(d) Community Renewal Program treatment ranging from conservation to clearance-and-reconstruction.

This analysis revealed zones which have reached stable population levels, those with a potential for growth in excess of the city-wide average and those likely to experience moderate population increases.

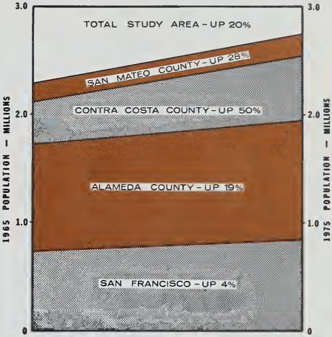
Employment Projections for San Francisco

Employment estimates for San Francisco by the State Employment Department indicate that the annual increase in jobs has been relatively stable since 1947—averaging 3,750 jobs per year between 1947 and 1955, and about 3,670 jobs per year since 1955. Based on its expectation that short-term population gains will occur primarily in the "non-working" age groups (under 18 and over 60), the State Employment Department has projected a decline in the rate of growth in overall employment through 1970, but accelerated growth rates in the financial and administrative sectors. NCTDP has projected the equivalent of an average annual increase of 3,055 jobs through 1975, developing a total city employment of 513,000.

Employment projections for the 172 zones in San Francisco were prepared by first examining past trends of residential, commercial and industrial acreages for each zone using information reported in the City Planning Department's *The Use of Land in San Francisco,* and the influence of the city's master plan and Community Renewal Program. Second, the employment distribution, developed by the City Planning Department for major geographic areas of the city, was revised for 1975 to allow for differential rates of growth in the financial and Civic Center districts. Finally, the zone trends originally developed were applied to the Planning Department's geographic areas subtotals to derive zonal employment projections. Downtown employment location was refined to account for proposed office structures committed for construction.

FIGURE 27

NCTDP STUDY AREA POPULATION GROWTH 1965 – 1975



San Mateo County Projections

Population projections for 1970, 1980 and 1990 were available for northern San Mateo County, permitting NCTDP to derive zone projections by interpolation. The County Planning Commission developed high and low estimates for 1975 and reviewed NCTDP projections in light of their findings. The Planning Commission's suggestions were incorporated in the NCTDP estimates. Employment projections for 1975 were interpolated in the same fashion.

Alameda County Projections

The Alameda County Planning Department in its 1965 *General Plan* presented population projections for 1970, 1980 and 1990. Interpolation between the 1970 and 1980 projections results in a 1975 population of 1,239,500, which is in close agreement with projections prepared

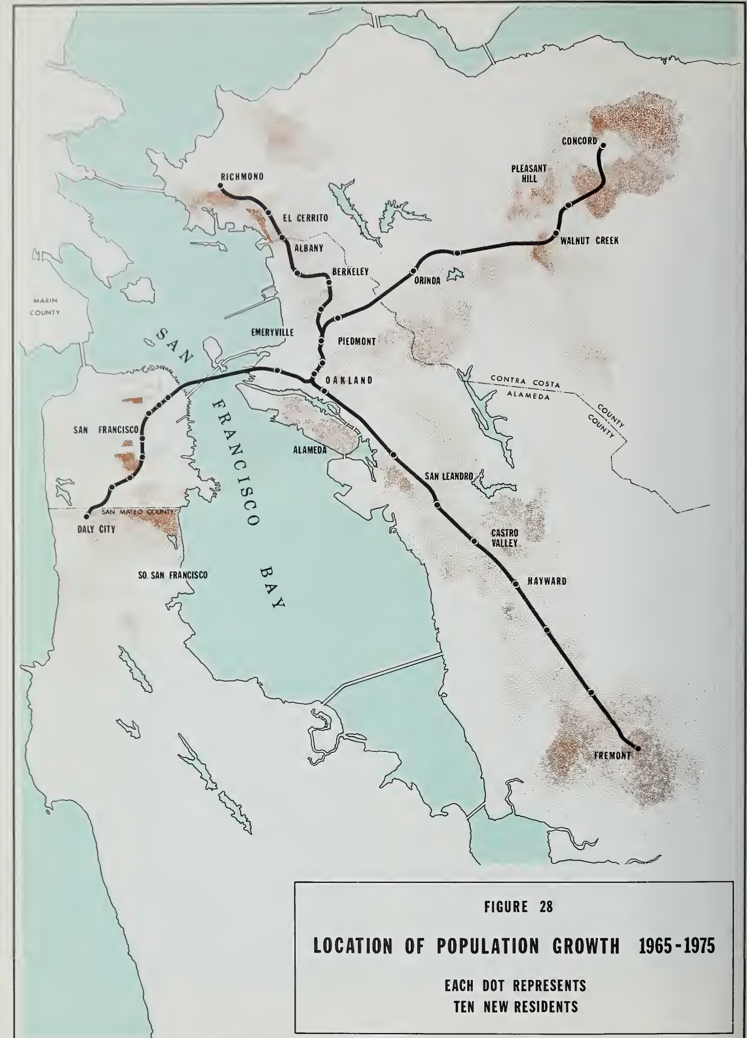


FIGURE 28

LOCATION OF POPULATION GROWTH 1965-1975

EACH DOT REPRESENTS
TEN NEW RESIDENTS

in 1962 by BARTD consultants and by the California Department of Finance—1,227,000 and 1,237,600, respectively.

NCTDP used the County Planning Department's projections for four planning units adjusted where planning information furnished by local planning departments and/or the County Planning Department itself indicated the necessity to do so. These refinements resulted in a 1975 population estimate for the portion of Alameda County within the NCTDP study area of 1,125,960.

The State Employment Department defines several community labor markets within the NCTDP study area including:

(1) Berkeley and Albany;
(2) Emeryville, Oakland, Piedmont and San Leandro;
(3) Alameda;
(4) Castro Valley, Hayward and Union City;
(5) Fremont and Newark.

For the 1955-1964 period, the County Planning Department has presented annual employment data for each labor market by employment sector.

Distribution of the projected 1975 employment totals among zones in Alameda County was accomplished through techniques similar to those used in San Francisco. Heavy reliance was placed upon the Alameda County land use plan and the land use plans prepared by the local planning agencies in the county. In each labor market the employment projections by sector were combined into two groups: "commercial" employent and "industrial" employment. Commercial and industrial employment for each zone for 1975 was assigned in proportion to the zone's share of projected commercial and industrial acreage for its labor market.

Exceptions to this general approach were the zones in downtown Oakland, and the University of California area, for which special employment projections were obtained from the Oakland and Berkeley Planning Departments, respectively.

Contra Costa County Projections

Two distinct portions of Contra Costa County are included in the study area. Thirty-three zones are in the Richmond-El Cerrito-San Pablo area, for which the Richmond City Planning Department has developed both population and employment projections for a set of zones compatible with NCTDP zones.

Thirty-five additional zones are in central Contra Costa County in the general area between Orinda and Concord. The Contra Costa County Planning Commission has prepared 1990 census tract population estimates for this area; 1975 population figures were derived by NCTDP, interpolating from the 1965-1990 trends. Employment projections were developed in a manner identical with that described for Alameda County.

Population and Employment Trends in San Francisco

In San Francisco, population and employment analyses were made on the basis of the central business district and six transit corridors having substantial community of interest as well as a distinct flow towards the CBD.

Population Trends in San Francisco

The San Francisco CBD, which is the economic hub of the Bay Area, and the focal point for the six corridors, is the smallest part of San Francisco in terms of *resident* population (Table 37). Population density for the CBD, as a whole, was a relatively high 36.5 persons per acre primarily because the downtown area includes part of the densely populated lower slopes of Nob Hill.

Significant population increases are anticipated in the Ingleside Corridor; this is a residential area in the southwest corner of the city whose downtown accessibility is hampered by Twin Peaks. In 1965, this corridor accounted for 12% of the city's population with densities ranging from 30 to 40 persons per acre.

The Marina Corridor will have the lowest rate of population growth. It has reached a full state of maturity with some of the highest residential densities in the city. In the southern end of the corridor, near Chinatown, gross population densities range upwards of 140 persons per acre. The Russian Hill-North Beach section is second only to Chinatown with population densities of 60 to 100 persons per acre.

High densities are also encountered in the Richmond Corridor stretching west from the CBD to the Pacific Ocean. This mile-wide corridor accounts for almost one-quarter of the city's population with an average density of 42 persons per acre. The dense residential development in this section of the city houses the CBD's "white-collar" work force—the transit

O-D survey revealed that three-quarters of the transit trips originating in this area end in downtown San Francisco. The Richmond Corridor has the highest population in the city and is expected to maintain the city-wide average in growth rate to 1975, with a projected total of over 175,000 persons. These projected values, in conjunction with the transit origin-destination data, are sufficient to identify this section as a prime corridor for rapid transit development.

The Mission Corridor—to be directly served by BARTD—is well developed but will experience modest population gains as result of planned urban renewal in the southern section of the city. This corridor, at its outer end, flows into Daly City through one of the few land egress routes from San Francisco.

The eastern half of the Bayview Corridor is highly industralized, accounting for this area's low gross residential density (13 persons per acre). In the residential areas on the west side of the corridor, densities range between 20 and 40 persons per acre.

Employment Trends in San Francisco

Downtown San Francisco is experiencing a construction boom. In 1965, more than one million square feet of office space were added, bringing the city's space reservoir to almost 20 million square feet. The bulk of the construction is going into skyscrapers in the financial district with visible proof provided by the maze of cranes and scaffolding on Montgomery and Sansome Streets. The title to 'tallest building in the city' will change hands four times before BARTD opens.

In 1965, with 282,000 jobs, the CBD accounted for 58% of San Francisco's total employment. A second measure of downtown economic intensity is revealed by its employment density, which averages 216 jobs per acre (Table 38). Another 19,000 jobs will be filled in the area by 1975 bringing total employment in the CBD alone to over 300,000. This gain in downtown employment will represent nearly two-thirds of the total job gain throughout San Francisco in the 10-year span from 1965 to 1975.

The largest increases in employment will flow from the building boom in the financial center where present-day densities of over 700 jobs per acre exist.

Modest gains will be experienced in other sectors of the city through normal employment growth. Substantial increases are expected in the industrialized areas of the Bayview Corridor and the densely developed Marina Corridor which has the highest employment density in the city outside of the CBD (see Table 38).

Table 37

SAN FRANCISCO POPULATION GROWTH
1965 - 1975

	1965		1975		1965 - 1975
Area	Population	Persons Per Gross Acre(a)	Population	Persons Per Gross Acre(a)	Increase In Population
CBD	47,724	36.5	49,607	38.0	4.0%
Marina Corridor	75,533	44.3	76,807	45.0	1.7
Richmond Corridor	169,216	41.9	175,719	43.6	3.8
Sunset Corridor	137,702	32.1	140,553	33.0	2.1
Ingleside Corridor	92,604	23.0	100,831	25.1	8.9
Mission Corridor	132,381	35.2	136,565	36.3	3.2
Bayview Corridor	99,815	13.0	104,246	13.6	4.4
TOTAL	754,975	29.8	784,328	30.9	3.9%

(a) Excludes the Presidio, Golden Gate Park and Lake Merced Area.

Table 38

SAN FRANCISCO EMPLOYMENT GROWTH
1965 - 1975

Area	1965 Employment	1965 Jobs Per Gross Acre(a)	1975 Employment	1975 Jobs Per Gross Acre(a)	1965 - 1975 Increase In Employment
CBD	282,000	215.9	301,000	230.5	6.7%
Marina Corridor	39,540	24.9	42,100	26.5	6.5
Richmond Corridor	33,190	8.2	34,825	8.6	4.9
Sunset Corridor	12,370	2.8	12,930	2.9	4.5
Ingleside Corridor	8,975	3.0	9,275	3.1	3.3
Mission Corridor	32,095	8.5	33,930	9.0	5.7
Bayview Corridor	74,670	9.8	79,335	10.4	6.3
TOTAL	482,840	19.0	513,395	20.2	6.3%

(a) Excludes the Presidio, Golden Gate Park and Lake Merced area.

Population and Employment Trends in Alameda County

Communities in Alameda County within the NCTDP study area are expected to grow by nearly 20% in the 10-year period 1965-1975 (Table 39). This coastal section of the county totals almost a million persons, with the northern metropolitan portion—Albany, Berkeley, Emeryville, Oakland, Piedmont and Alameda—accounting for about 60% of that number. In the decade to 1975, it is anticipated that this will increase by almost 200,000 persons to an aggregate of 1,158,000. More than three-quarters of this increase will occur in the southern portion—in the less intensely developed communities such as Fremont, Newark, Union City, etc.

Oakland is the largest city in Alameda County and also the most fully developed. A projected increase of 14,400 residents, less than 4% of present population, is expected by 1975, with most of this growth in the eastern hilly portion and the southern section of the city.

Berkeley is one of the more densely developed communities in the East Bay, particularly in the vicinity of the University of California campus, where densities range up to 30 persons per acre. This community will grow only slightly in the next decade 'by its own choice.' Land use plans developed by the city reflect a desire to maintain present residential population densities in Berkeley.

The small cities of Emeryville and Piedmont are frequently associated with Oakland by reason of geography—Piedmont is completely surrounded by Oakland. Emeryville will remain essentially industrial in character through the projection period, accounting for its present and projected low density rates. Modest increases are anticipated in Piedmont; it should remain one of the exclusive residential communities in the Bay Area.

Increases in the Castro Valley area are expected to occur in the areas south and east of Lake Chabot—the least densely populated portion.

More than one-half the growth in Alameda County over this 10-year span will take place in the Fremont-Union City area. The city of Fremont is expected to nearly double in size to a community of 165,000 people by 1975. It is projected to be substantially larger than Berkeley or San Leandro.

The island city of Alameda had approximately 56,000 residents in 1965, with another 8,000 seamen listed as crews of vessels docked there. The resident population of the city is expected to increase by about 10,000 persons by 1975.

Table 39

ALAMEDA COUNTY POPULATION GROWTH
1965 - 1975

	1965		1975		1965 - 1975
Community	Population	Persons Per Gross Acre	Population	Persons Per Gross Acre	Increase In Population
Alameda	56,035 (a)	9.7	65,055	11.4	16.1%
Albany	15,503	17.2	20,200	22.3	30.3
Berkeley	117,199	16.6	124,200	17.6	6.0
Emeryville	2,700	3.8	3,000	4.2	11.1
Oakland	376,783	11.0	391,186	11.4	3.8
Piedmont	11,232	11.3	12,000	12.1	6.8
San Leandro	90,968 (b)	8.6	101,915	9.5	12.0
Hayward	150,558	5.9	167,500	6.4	11.3
Castro Valley	45,743	8.1	59,590	10.5	29.6
Fremont	81,118	2.3	156,000	4.4	92.3
Newark	20,871	5.7	38,000	10.4	82.1
Union City	9,756	1.7	19,500	3.4	99.9
TOTAL	968,710	7.1	1,158,146	8.5	19.6%

(a) Excludes crews of civilian vessels.
(b) Includes San Lorenzo.

Employment Trends in Alameda County

Employment in the study area section of Alameda County totaled 365,280 jobs in 1965. Differential rates of employment growth follow the pattern of population increases to the extent that the upper portion of the county currently accounts for about 85% of total jobs.

The number of jobs is projected to increase by 68,500 in the 10-year span to 1975. Almost one-half of this expected increase will occur in the relatively undeveloped southern portion of the county (Table 40). These projections were developed with heavy reliance on data supplied by the Alameda County Planning Department for five community labor markets as defined by the California Department of Employment.

Highest employment densities in the county are encountered in the downtown Oakland area where the CBD core aggregates 150 jobs per acre. 1975 increases range from lows of 4% in the fully developed Oakland-Piedmont-Emeryville area to highs of almost 90% in the sparsely developed Fremont-Union City area and 96% in Alameda.[2] Aggregate employment increase for the county is projected at 18.7%.

Population and Employment Trends in Contra Costa County

As previously indicated, the portion of Contra Costa County in the NCTDP study area is divided into two sub-areas for analysis purposes: the Richmond-San Pablo-El Cerrito area and the section east of Berkeley Hills, including Lafayette, Walnut Creek, Pleasant Hill, Concord and vicinity.

Richmond-San Pablo-El Cerrito Area

In 1965, the population of the Richmond-San Pablo area was estimated at 168,072; this is

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[2] This projection for a settled city like Alameda may appear high, but is the logical derivative from the industrial land use development in this decade as projected by the city's planning department. This projected development, together with the city's proximity to distribution centers in the central metropolitan portion of the county, should enable the city of Alameda to compete on favorable terms with the southern portion of the county in the immediate future. Heretofore, the city has made no substantial effort to attract industry and commerce, but now is embarking on a more aggressive program of industrial and commercial expansion.

Table 40

ALAMEDA COUNTY EMPLOYMENT GROWTH
1965 - 1975

	1965		1975		1965 - 1975
Community	Employment	Jobs Per Gross Acre	Employment	Jobs Per Gross Acre	Increase In Employment
Alameda	17,910	3.1	35,130	6.1	96.1%
Albany	5,070	5.6	5,525	6.1	9.0
Berkeley	58,215	8.3	63,955	9.1	9.9
Emveryville	14,200	19.8	14,800	20.6	4.2
Oakland	212,487	6.2	221,452	6.5	4.2
Piedmont	1,090	1.1	1,140	1.2	4.6
San Leandro (a)	9,967	.9	14,905	1.4	49.5
Hayward	22,450	.9	33,505	1.3	49.2
Castro Valley	4,438	.8	6,630	1.2	49.4
Fremont	12,965	-	24,472	-	88.8
Newark	2,830	.8	5,340	1.5	88.7
Union City	3,655	.6	6,900	1.2	88.8
TOTAL	365,277	2.7	433,754	1.2	18.7%

(a) Includes San Lorenzo.

projected to increase to 210,000 by 1975. Throughout this region, population densities range in general between 10 and 20 persons per acre, except for a few zones of heavier density in Richmond and San Pablo proper.

With respect to employment, relatively heavy increases—in excess of 30%—are forecast for parts of Richmond. Job gains in excess of 10% are projected for San Pablo, El Cerrito and the remainder of Richmond.

Eastern Contra Costa County

In 1965, the population of eastern Contra Costa County was estimated at 215,800. This is projected to reach 363,600 by 1975—a rise of 68%. Except for a portion of Concord, population density throughout this area is less than 10 persons per acre. Even with the projected rise of more than two-thirds, this will remain comparatively sparse in 1975.

Eastern Contra Costa County is destined to remain primarily residential. Jobs will rise as communities develop in size but at less than one-half the rate of population growth. An overall increase in employment of 30% is projected for the 1965-1975 period, matching the 68% rise in total population.

Population and Employment Trends in Northern San Mateo County

The NCTDP study area includes all of Daly City, South San Francisco, San Bruno, the San Francisco International Airport area, and other zones in northern San Mateo County. Population and employment projections for these areas were interpolated for 1975 from projections for 1990 supplied by the San Mateo County Planning Department.

Population of San Mateo within the study area is estimated at 170,465 in 1965 and projected to increase to 218,450 by 1975. Except for a few sections of Daly City, population density throughout the area is less than 20 persons per acre and will remain at relatively low density a decade hence.

Local employment is not a significant item in northern San Mateo County, except at the San Francisco International Airport and in South San Francisco since most communities within the study area are primarily residential. Employment in 1965 was 45,130. This is expected to rise by 13,870 jobs, or 30.7%, to a total employment of 59,000 by 1975.

CHAPTER 10

Transit Travel in 1975

TRANSIT TRAVEL IN 1975 embraces two primary considerations, (1) the anticipated volume of passengers using surface and rapid transit service, and (2) the layout of routes to accommodate this anticipated riding. Both considerations are interdependent; the heart of this NCTDP program is development of the plan for coordination of routes which will optimize future transit travel in the Bay Area.

With more than 120 surface transit lines and 75 miles of rapid transit connecting 474 zones throughout the Bay Area, the number of alternative route combinations which might be evaluated is limitless. Under the systems approach utilized in this study for simulating transit networks and testing each network by travel estimation models, the goal of defining the optimum system was brought within manageable proportions.

Coordinated transit networks[1] and trip generation models permitted simultaneous testing of a complete set of route configurations with each system analysis. In a typical test run, all 120 (or more) surface transit routes, as well as rapid transit lines, were laid out to match anticipated travel desires. This produced a test network which then was coded for machine simulation and 'loaded' with the future origin-destination travel matrix to reveal the resulting use of each transit route in the system. This testing procedure is not dissimilar to layout of a water supply network, wherein trip origin points are reservoirs and outlet faucets are destinations; the simulation process opens the valves over the entire system, then measures the flow in each pipe to the outlet points. Alternate layouts are tested by changing pipe sizes or using different hookups.

When each transit network was coded, computers were used to find the desired route of travel from the 474 origin zones in the Bay Area to each of 473 possible destinations. This step searched out nearly a quarter of a million 'travel paths' through which anticipated transit trips would flow from origin to destination. These minimum paths then were quantified and the travel loads on each link of the test network accumulated to develop the prospective use of transit routes in that network.

Development of Test Networks

In order to limit the number of possible alternatives, a testing program was devised for bracketing the ultimate solution by first testing the extreme possibilities, then refining between them. In the case of AC Transit, two basic network philosophies were first evaluated. In one such test, no changes were made in the AC Transit transbay and East Bay express routes, except that the BARTD rapid transit alignment was superimposed on them. This arrangement was developed to assess the impact of BARTD on the existing AC Transit network and point up those routes which would not withstand competitive BARTD service. The other extreme for AC Transit operations was then analyzed in the second test run; all transbay routes and East Bay express lines were eliminated while arterial, crosstown and feeder routes were rerouted to stations to facilitate transfer to BARTD under both test networks.

Similar bracketing was done in the San Francisco layouts by testing a rapid transit 'feeder plan,' paralleling that developed by Toronto Transit system for linking surface routes into its newly built subway lines. Under this arrangement, the principal emphasis was placed on rerouting Muni surface lines to feed BARTD and other proposed Muni rapid transit lines so as to optimize the use of these grade-separated facilities. The other extreme was a so-called 'through route' plan which stressed the advantages of one-vehicle service by having rapid and surface transit facilities laid out for direct service to principal traffic generators by either mode.

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[1] Simpson & Curtin, *Technical Memorandum No. 13: Estimating Future Transit Use*, Appendix, p. A4, (February, 1966).

Neither of the extreme networks on either transit system was tested with the thought that it would produce the recommended network. However, these alternatives quickly pointed up the significant aspects of each and provided the range within which the properly coordinated network could be expected to fall.

Succeeding proposals then were tested for each system by linking the favorable alternatives developed from prior test runs. Five complete transit networks were developed for the AC Transit system and four complete arrangements for the Muni system before the recommended plan was finally determined. When the computers indicated that further network refinements would not produce higher transit volumes or faster travel, the optimum future transit system for the Bay Area was accomplished.

1975 TRANSIT MARKET

The transit market in the Bay Area is estimated to increase from 534,731 adult trips daily in 1965 to a new pool of 673,109 adult trips in 1975.[2] If school children are added, the projected market for transit at the three-quarter century mark will be 812,000.

The principal factor underlying this 26% gain in transit use over 10 years is the addition of BARTD and a supplementary three-part Muni rapid transit system in San Francisco. Population growth is also a factor, but its effect is primarily to offset the prevailing diversion of

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[2] The 1975 volumes are developed from the transit estimation process on the basis of continuation of 1965 fare levels. Therefore, the total pool of adult transit riding does not reflect any adjustments for the effect of proposed fare changes to be considered in succeeding chapters.

Table 41

BAY AREA AVERAGE WEEKDAY ADULT TRANSIT TRIPS
1965 - 1975

	Average Weekday Adult Transit Trips		% Change
	1965	1975	
TRANSBAY			
AC Transit	33,541	3,640	
Greyhound	8,054	-	
BARTD	-	71,604	
Total	41,595	75,244	+80.9%
EAST BAY			
AC Transit	91,719	53,845	
Greyhound	1,908	-	
BARTD	-	56,605	
Total	93,627	110,450	+18.0%
SAN FRANCISCO - WEST BAY			
Muni Surface	382,188	154,428	
Muni Rapid	-	198,949	
BARTD	-	113,080	
Greyhound	17,321	20,958	
Total	399,509	487,415	+22.0%
TOTAL	534,731	673,109	+25.9%

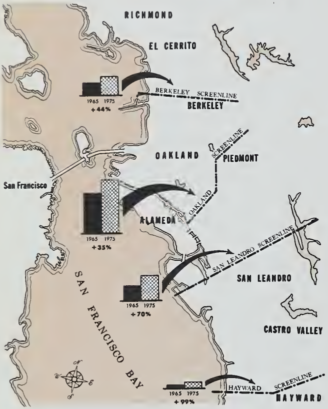
transit rides to automobiles. In the 10-year span from 1955 to 1965, transit riding declined in the Bay Area notwithstanding a 20% increase in population.

Transbay travel will develop the largest share of increased transit usage; an 81% increase from 41,600 adult trips currently to 75,244 daily in 1975 is projected (Table 41). All of this gain as well as most present transit riders crossing the Bay will be on BARTD. AC Transit system is expected to continue in transbay service, but at a much reduced level. Compared with a daily level of 33,540 AC Transit transbay patrons in 1965, the traffic estimation process foresees only 3,640 bus riders over the Bay Bridge daily in 1975—a drop of nearly 90%. In addition, all Greyhound patronage from Contra Costa County to downtown San Francisco—more than 8,000 riders daily—will be diverted to BARTD.

For trips wholly within the East Bay area, the impact of BARTD is not expected to be as severe upon the AC Transit system. The total number of East Bay adult journeys is projected to rise from 93,627 to 110,450 daily in 1975, a gain of 18% (Figure 29). BARTD will divide this East Bay market with AC Transit on an approximately equal basis. While it will lose a significant share of East Bay travel, AC Transit will more than offset this passenger decline by gaining a high proportion of feeder trips to BARTD stations for both East Bay and transbay rapid transit journeys. The net result will be an overall gain of 12% in the number of passengers handled by AC Transit, but for trips of considerably shorter length.

FIGURE 29

EAST BAY TRANSIT TRAVEL GROWTH



The impact of BARTD on the Muni system is not expected to be as great. The total number of San Francisco adult journeys is projected to rise from 399,509 to 487,415 daily in 1975, an overall gain of 22%. BARTD will divide this San Francisco market with Muni, but the latter is expected to retain about three-fourths of the total. Even with this lesser proportion, however, San Francisco will represent the prime market for BARTD riding due to its greater aggregate volume. While surface route volumes will drop significantly, Muni will offset this passenger decline with new rapid transit riding and also by gaining feeder trips to BARTD stations.

BARTD RIDING IN 1975

By 1975, the dominant transit attraction throughout the Bay Area will be the BARTD system. To a considerable degree, optimizing transit use in the area means optimizing use of BARTD since this facility will have the greatest passenger appeal. This principle has been followed in developing the coordinated route plan, i.e., maximizing the use of rapid transit wherever possible. The result is that nearly one out of every three transit trips in 1975 will use BARTD for at least part of the journey.

It is expected that BARTD will accommodate over 253,000 potential daily riders in 1975, as follows:

San Francisco local trips	120,159
Transbay travel	73,036
East Bay local trips	60,158
Total	253,353[3]

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[3] This total represents 241,289 adult riders and 12,064 school and child trips from the coordinated network prior to adjustments for alternative fare plans. For details of the fare adjustment procedure, see Chapter 12.

BARTD riding is projected to be essentially radial in nature, with volumes accumulated on the three East Bay legs aggregating a total load of 73,036 transbay trips a day (Figure 30). The maximum accumulation on the entire system will occur on Market Street in downtown San Francisco between the Civic Center and Powell Street Stations and total 84,370 adult rides. Maximum East Bay volumes will occur on each BARTD route in the vicinity of downtown Oakland.

Traffic on the Richmond and Fremont legs of BARTD will be evenly distributed between local East Bay trips and transbay trips. However, the Concord leg will range up to a three to one ratio, transbay to local. Volumes on the San Francisco leg will vary from practically 100% local on the outer sections to almost 25% transbay in downtown San Francisco.

Station Usage

The most heavily used BARTD station will be Montgomery Street in downtown San Francisco, with over 116,000 passengers boarding and alighting daily. As shown on Table 42, more than 95% of these will be at the attraction end of their journeys on their inbound trip and similarly will be returning to their home or production ends on the evening outbound trip. This imbalance points up the prospective heavy loads on components of the toll collection equipment in the morning and evening peaks.

Other heavily used stations on the San Francisco side will be Civic Center and Powell Street, each handling over 30,000 passengers daily. In the East Bay, the principal passenger stations will be Fruitvale, 12th Street and 19th Street in Oakland and the Berkeley station. These are expected to be used by less than one-half of the volume of downtown stations in San Francisco.

The residential sections at the end of BARTD lines are evident from examination of the overwhelming number of trip productions as compared to attractions at BARTD stations on Table 42. At the outer ends of the San Francisco line, trip productions amount to more than 90% of station usage. This percentage drops progressively as stations approach the commercial sections of the city along Mission and Market Streets, dropping down to less than 5% at the Montgomery Street Station.

The same general pattern is evident in East Bay travel on BARTD. The predominantly residential character of stations at the outer ends of each of the three lines is revealed in the high percentage of trip productions. This drops steadily as the lines converge on downtown Oakland where the attraction of stores and commercial buildings for transit service increases the overall volume of station usage, but results in a lower proportion of trip productions to less than 40%.

This station usage data is significant not only in establishing the time and directional flow but also for demand characteristics on fare collection facilities at each of the BARTD stations.

BARTD Speed

BARTD's major contribution to improved transit travel in the Bay Area will be its significant increase in speed. Average speed from the ends of BARTD lines to downtown San Francisco will be 40-50 miles per hour, including station stops (Table 43). This will be three or more times as fast as the present Muni and AC Transit operations. Even the transbay service, which now runs at 19 miles per hour, will be substantially improved by rapid transit,

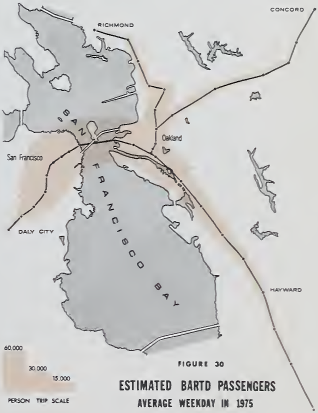

FIGURE 30

ESTIMATED BARTD PASSENGERS

AVERAGE WEEKDAY IN 1975

Table 42

PASSENGER VOLUME AT BARTD STATIONS IN 1975
(Adult Riders Prior to Adjustment for Fare Differentials)

Station	Total Boarding and Alighting			Percent Productions
	Productions (Home End)	Attractions (Non-home End)	Total	
Daly City	8,954	888	9,842	91.0%
Balboa Park	20,647	2,076	22,723	90.9
Glen Park	22,789	2,465	25,254	90.2
24th Street	19,306	6,891	26,197	73.7
16th Street	16,210	11,650	27,860	58.2
Civic Center	16,640	21,303	37,943	43.9
Powell Street	6,680	25,660	32,340	20.7
Montgomery Street	5,370	110,854	116,224	4.6
Subtotal - San Francisco Line	116,596	181,787	298,383	39.1
Oakland West	3,080	1,482	4,562	67.5
12th Street	7,235	11,323	18,558	39.0
19th Street	3,789	10,193	13,982	27.1
MacArthur	4,149	4,166	8,315	49.9
Subtotal - Oakland Stations	18,253	27,164	45,417	40.1
Ashby Place	4,677	1,255	5,932	78.8
Berkeley	8,436	6,791	15,227	55.4
North Berkeley	3,674	554	4,228	86.9
El Cerrito Plaza	3,870	355	4,225	91.6
El Cerrito del Norte	4,680	398	5,078	92.2
Richmond	2,967	669	3,636	81.6
Subtotal - Richmond Line	28,304	10,022	38,326	73.9
Rockridge	3,751	629	4,380	85.6
Orinda	1,245	141	1,386	89.8
Lafayette	1,711	72	1,783	96.0
Walnut Creek	3,116	202	3,318	93.9
Pleasant Hill	2,484	85	2,569	96.7
Concord	3,366	435	3,801	88.6
Subtotal - Concord Line	15,673	1,564	17,237	90.9
Lake Merritt	9,696	9,155	18,851	51.4
Fruitvale	20,199	3,602	23,801	84.9
Coliseum	7,440	902	8,342	89.2
San Leandro	7,679	2,646	10,325	74.4
Bay Fair	3,944	282	4,226	93.3
Hayward	6,007	2,261	8,268	72.7
South Hayward	2,125	302	2,427	87.6
Union City	2,612	809	3,421	76.4
Fremont	2,951	603	3,554	86.3
Subtotal - Fremont Line	62,653	20,562	83,215	75.3
TOTAL	241,289	241,289	482,578	50.0%

designed to cross the bay at running speeds of 70-80 miles per hour. The result is that Richmond, 20 miles away, will be less than one-half hour from downtown San Francisco while Concord, which is nearly 29 miles distant, will only be 35 minutes away. Even on the San Francisco side, the farthest point on the BARTD line, Daly City, is 7.6 miles distant; running time from Daly City to downtown San Francisco will be cut from the present trip length of 27 minutes to 12½ minutes—a 54% reduction.

Table 43

AVERAGE BARTD SPEEDS
TO DOWNTOWN SAN FRANCISCO

Area	Miles	Minutes	Average Speed
Richmond	19.9	27.2	44 m.p.h.
Fremont	30.8	36.3	51 m.p.h.
Concord	28.6	34.6	50 m.p.h.
Daly City	7.57	12.5	36 m.p.h.

BARTD Impact on Auto Travel

A substantial share of BARTD traffic will come from present auto users, according to the NCTDP trip forecasting analysis. It is estimated that 32.3% of BARTD travelers in the East Bay will be diverted from automobiles. In the transbay service, BARTD will attract 30.3% of its patronage from motorists now crossing the Bay Bridge.

These diversion estimates represent a higher proportion of transit usage from auto travel than any other rapid transit facility has been able to attract heretofore (Table 44). Yonge Street Subway in Toronto draws 12.9% of its patronage from former auto users, while the two newer rapid transit systems in Chicago—the Congress Street Rapid and the Skokie Swift—have been able to divert 12.5% and 17.5% respectively. It is expected that BARTD will be more than twice as effective as these other rapid transit developments in luring motorists out of automobiles; this expectation is not unwarranted in the light of high operating speeds and the forthright appeal to motorists in passenger comfort and amenities being built into the BARTD facility.

The most significant impact of BARTD will be upon the San Francisco-Oakland Bay Bridge. While BARTD will have its greatest effect volumewise upon transbay riding now being carried by AC Transit over the Bridge, a far greater benefit to the communities will be its diversionary influence upon peak hour traffic movements over the Bridge. It is estimated that 21,000 transbay auto-person trips will be diverted daily to BARTD in 1975. At prevailing average occupancy of 1.47 persons per car, this is the equivalent of 14,300 autos daily, the predominant share of which will be in the heavy flow direction during peak hours. In terms of peak hour lane usage, 3,200 *vehicles* in the peak hour/direction will be diverted off the Bridge to BARTD. This represents more than two lanes of auto travel. When combined with the fact that 80% of transbay *buses* will also be removed, the net effect of BARTD will be to add three peak hour/direction lanes to present auto and bus travel across the bay.

The foregoing calculation does not take into account the fact that AC Transit now provides the equivalent of four traffic lanes of patronage on the Bay Bridge in both the morning and evening peak hours. BARTD will assimilate nearly 90% of this bus volume and, in addition, divert more than two lanes of auto travel to subway movement. The overall effect of BARTD, therefore, will be the equivalent of seven transbay lanes in the peak hour/peak direction. In other words, BARTD will be equal to another Bay Bridge in delivering East Bay residents to downtown San Francisco every morning.

Another major element in casting up the community benefits from rapid transit development will be the effect of BARTD in clearing downtown streets and garages in San Francisco. The San Francisco Department of City Planning has recently estimated that ". . . each additional automobile entering the downtown during the rush hour requires an additional investment in street and parking space amounting to $25,000. The carrying charges on this investment work out to about four dollars per round trip per automobile."[4] Transbay autos alone diverted from downtown streets by BARTD will represent an annual saving to the City of San Francisco of $3,600,000; if local traffic is added, this will exceed $7,000,000.

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[4] San Francisco Department of City Planning, *Working Paper 1, Transportation Plan,* December, 1966.

Table 44

PREVIOUS MODES OF TRAVEL
OF RAPID TRANSIT RIDERS

Rapid Transit Facility	Previous Travel Mode		
	Surface Transit	Automobile	Other
Skokie Swift (Chicago)	75.2%	17.5%	7.3%
Congress Street (Chicago)	85.4%	12.5%	2.1%
Yonge Street Subway (Toronto)	86.2%	12.9%	0.9%
NCTDP ESTIMATED BARTD USE			
East Bay	67.7%	32.3%	-----
Transbay	69.7%	30.3%	-----

It should be pointed out in this connection that the cost of parking garage space in San Francisco is several times that of other American cities. Costs reported[5] by the San Francisco Parking Authority range from $3,088 per car space at the Civic Center garage to a high of $6,684 per car space at the Sutter-Stockton garage. This compares with average figures in other parts of the United States of $1,200 per car space in the central United States to $1,800 per car space in the eastern states.[6]

AC TRANSIT TEST NETWORKS

As previously pointed out, five complete transit networks in the East Bay were developed and tested in order to explore fully the range of route combinations between the AC Transit system and BARTD. The first two of these (Plans A and B) were extreme proposals, designed to bracket BARTD's effect on existing East Bay transit. These initial tests furnished the basis for modifications of subsequent route layouts and refinements (Plans C and D) for further testing, leading to a recommended optimum network (Plan E) for the East Bay.

East Bay Plan A

This first inquiry was designed to reveal the impact of BARTD on existing AC Transit operations without making any changes in the 16 AC Transit transbay and seven East Bay express routes. The three East Bay BARTD legs were simply superimposed on them and conditions simulated with both services competing.

Six East Bay arterial routes were changed to facilitate transfer to BARTD, while 20 of the 22 crosstown and feeder routes were modified to provide direct connection with BARTD. In total, minor modifications were made in 26 of the 65 AC Transit operating routes.[7]

Test results showed that some transbay bus routes hold up reasonably well in relation to their present volumes, even with BARDT in operation. The better performers include transbay Routes N-V which retained 56% of 1965 riders, O-W with 40%, Route C with 38% and B with 37%. The rest of transbay bus routes retained less than one-third of their 1965 passenger volumes against BARTD in transbay competition. These estimated bus volumes include not only the effect of diversion to BARTD but also the anticipated population growth in the

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[5] Physical and financial facts regarding San Francisco garages in 1959, San Francisco Parking Authority.

[6] *Journal of the American Concrete Institute*, December, 1959.

[7] The number of operating routes differs from the 52 routes used in Chapter 4 which were combined for accounting purposes.

East Bay, ranging from 7% in Oakland to more than 50% in outlying portions of the transit district.

Plan A was deemed unsatisfactory not alone for its impact upon AC Transit transbay services but also for its diversional effect upon BARTD. AC Transit would be operating a host of unprofitable routes, while subsequent testing indicated that BARTD's transbay volume would only be 84% of that developed under succeeding route plans. However, Plan A did point up some East Bay areas not directly served by BARTD which will find bus service sufficiently fast and convenient to warrant its continuation. The transbay routes meriting attention from this standpoint include:

Route N-V—serving Lakeshore, Oakmore, etc., along MacArthur Boulevard;

Route O-W—serving Alameda via the Nimitz Freeway parallel to BARTD. To reach BARTD, Alameda passengers have to backtrack to Fruitvale and Lake Merritt Stations or travel to the 12th Street Station in downtown Oakland;

Route C —serving Piedmont, and the Montclair area between the BARTD Concord and Fremont legs;

Route B —serving the Lakeshore and Trestle Glen areas with freeway operation to the Bay Bridge.

Plan A revealed two of the seven East Bay express routes having significant gains in traffic over their 1965 volumes. Routes 34 and 38 show traffic gains for two reasons: (1) they serve growing territory—South Oakland to San Leandro—and, (2) they benefit from the redistribution of traffic between surface routes and BARTD due to travel time advantages. Routes 34 and 38 provide direct service to downtown Oakland from the south and east, whereas potential BARTD patrons from these areas will have to travel perpendicular to their desire line to reach a BARTD station.

The remaining East Bay expresses will have considerably reduced traffic volumes, primarily because their service areas lie directly on BARTD legs. Routes 31 and 33 serve Richmond and Berkeley, while Routes 30, 32 and 36 parallel the BARTD Fremont leg.

East Bay Plan B

Under Plan B, all transbay routes and East Bay express routes were eliminated, with the exception of Route 34 which demonstrated distinct travel advantages in the previous test. East Bay arterial, crosstown and feeder routes were modified to facilitate transfer to BARTD and provide optimum East Bay local service.

In the aggregate, 22 routes—16 transbay and six express—were eliminated and another 26 changed to coordinate surface operations with the rapid transit system. The remaining 17 routes—12 arterial, one express and four feeder lines—were not changed.

Table 45

TRAVEL TIME TO DOWNTOWN SAN FRANCISCO
FROM EAST BAY COMMUNITIES

Community	Existing AC Route	Travel Time (a) Existing (Minutes)	1975 Plan "A" (Minutes)	1975 Plan "B" (Minutes)	Proposed Plan (Minutes)
Richmond	Lx	41	32	31	31
Berkeley	Fxx	35	21	21	21
Alameda	Ox	33	33	36	33
Piedmont	Cx	34	34	38	34
Hayward	RFx	61	40	40	40

(a) Travel times are "portal-to-portal" with allowance for access to and from routes.

Under Plan B, the pendulum swung to the opposite extreme from that under Plan A, i.e., BARTD traffic in 1975 transbay service rose to 103% of its optimum level as ultimately determined. While maximizing BARTD utilization, several East Bay communities emerged with poorer travel times to downtown San Francisco under Plan B than they had with bus service under Plan A (Table 45).

Travel from Alameda to downtown San Francisco is three minutes faster by express bus operation than the proposed BARTD service. Similarly, Piedmont residents served by transbay express Route C will continue to have a 12% time advantage over rapid transit service. These continuing time advantages under Plan B with BARTD in operation explain the percentages of travel retained on certain bus routes, as previously indicated.

Analysis of the test results for both plans showed that travelers from the more distant communities—Richmond and Hayward, for example—will rely primarily on BARTD for San Francisco travel under either plan. Very little change was evident in their travel times under either extreme so that the transbay bus routes from these communities can be eliminated with little adverse effect.

East Bay Plan C

Plan C was a compromise of the extremes tested under the two preceding layouts, designed to incorporate the favorable components of each. Three transbay bus routes were retained to supplement the BARTD operation. Two of these—Routes N and V—operate through residential areas in East Oakland and San Leandro along MacArthur Freeway better served by express bus than by the BARTD Hayward line. Route B would also continue as at present in the East Bay, but would terminate at Treasure Island instead of San Francisco. Of the remaining 13 transbay routes, nine were eliminated entirely, three modified to become feeder routes to BARTD in the East Bay area, and Route T changed to run between San Francisco and Treasure Island only.

Route 34, previously described under Plan B, and one additional express route, No. 38, were retained in the East Oakland area from among the seven East Bay express routes presently being operated.

Modifications to the arterial and feeder routes resulted in 27 lines becoming feeders to BARTD, 12 remaining unchanged, two being modified for other reasons and one being eliminated. Also, under East Bay Plan C, two new feeder routes to BARTD were established.

This refinement in layout from prior proposals produced evident results both in reduced travel time to downtown Oakland and San Francisco and greater transit volumes across the bay. Under Plan C, BARTD transbay daily riders in 1975 rose from 60,600 attracted under Plan A to 70,400, a gain of 16%.

East Bay Plan D

Plan D was a refinement of Plan C incorporating some improvements made evident by the traffic testing procedure, along with changes suggested by AC Transit officials for smoothness of operation.

Additional transbay bus routes were included —Route B from the area east of the Oakland CBD, Route F from Berkeley, and Route O-W from Alameda.

The aggregate change in the 16 existing transbay routes consisted of six lines eliminated, six unchanged, three modified to become East Bay feeder routes to BARTD, and Route T modified to operate only between East Bay and Treasure Island.

Routes 34 and 38 of the seven express routes were included, as in Plan C. Some 27 arterials and feeders were modified to connect with BARTD, while one arterial was modified to serve the Oakland International Airport and one new feeder route to BARTD from the El Sobrante-San Pablo area was added.

Operating traffic and travel time results under Plan D were quite close to those realized under Plan C, indicating that a point of diminishing returns in the testing procedure had been reached. BARTD patronage in 1975 transbay service was 19% greater than that developed under Plan A and 97% of that estimated under Plan B. By sacrificing the added 3% of patronage to be gained under total elimination of all transbay bus routes, a choice of service was afforded to areas where the two modes produced reasonably comparable travel times, with distinct improvement to some areas—Alameda and Piedmont—which will not be benefited significantly by BARTD rapid transit service.

Recommended Network in East Bay

The recommended network for the East Bay —Plan E—is a further refinement of prior plans with some added route changes for more convenient service and smoothness of operation (Figures 31 and 32). In summary, 30 of the 65 routes are modified to feed BARTD, two are changed for reasons unrelated to BARTD, 21 are not changed, 12 are eliminated, and one new route is added.

Transbay Routes. Six transbay routes are proposed for continued operation. These include Routes B, N and V—all of which serve the area east and south of the Oakland CBD. Route O-W from Alameda also should be retained for reasons previously indicated. It is recommended further that transbay service be operated from the Piedmont area over the Highland Avenue branch of Route C via Harrison Street and MacArthur Boulevard.

These six remaining transbay routes are expected to carry a substantially lesser volume than they had in 1965:

Transbay Route	Adult Revenue Passengers		Percent Reduction
	1965	1975	
B	711,930	695,685	2.3%
CX	697,965	168,435	75.9
N V	1,256,280	314,925	74.9
O W	670,890	264,480	60.6
TOTAL	3,337,065	1,443,525	56.6%

With this 57% reduction and elimination of the remaining 10 transbay lines, AC Transit travel in transbay services will be reduced to 5% of the total market.

Several of these transbay routes are distinctly in question from a revenue-cost standpoint. They have service value and are included, therefore, in the recommended plan, although not essential to it.

The Broadway Terrace leg of present Route C will become a BARTD feeder, under the recommended plan. Also, former transbay Routes A, E and F will be modified to become BARTD feeders and local service routes. The San Francisco-Treasure Island leg of Route T will be eliminated, while the East Bay-Treasure Island service will continue with the eastern terminal at the BARTD MacArthur Station.

East Bay Routes. Two of the seven East Bay express routes—34 and 38—are retained in the recommended plan; the remaining five are eliminated.

With respect to the remaining 42 present routes in East Bay service, 28 are modified to become BARTD feeders, one is eliminated, and 13 remain unchanged. These changes are illustrated on Figures 31 and 32.

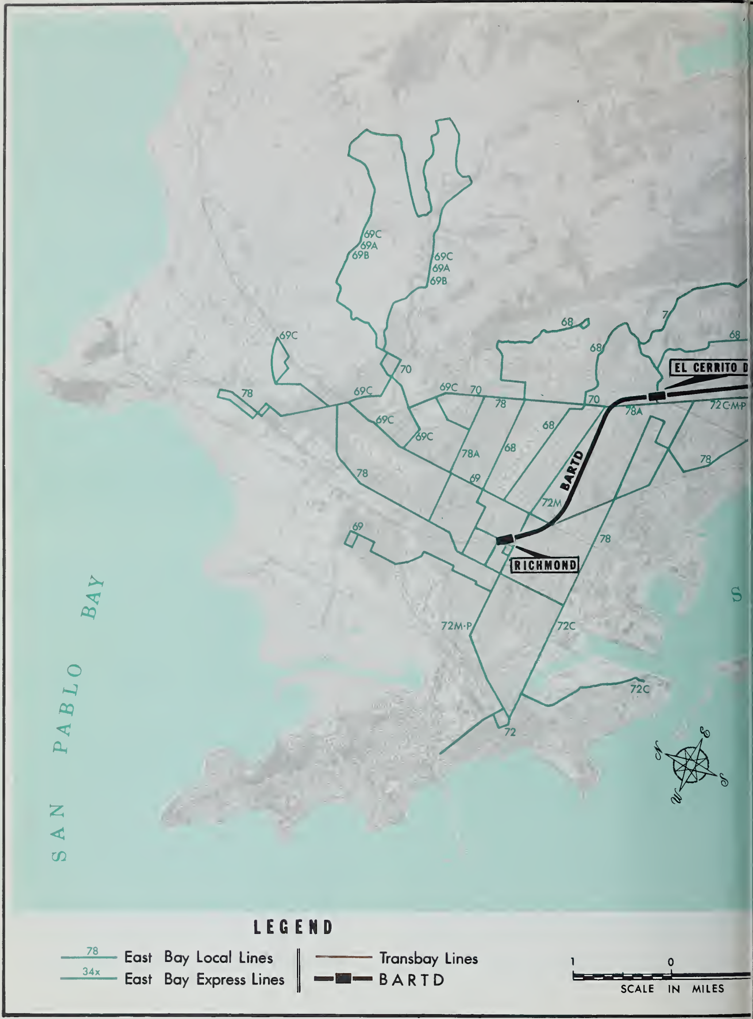
In the aggregate, the recommended system would consist of 48 basic routes—six transbay and two East Bay express routes, one special route to Treasure Island, 13 arterials and 26 crosstown and feeder routes.

While the reduction in transbay riding on AC Transit lines will be substantial, this decline will be more than overcome by the gain in feeder route traffic to BARTD. Total adult riding on AC Transit will increase by 1975 to over 43 million passengers annually from a 1965 level of 35,700,000—a gain of 21%. The shift in nature of AC Transit patronage to predominantly a short-haul feeder operation is reflected in the following comparison of revenue passengers for 1965 and 1975 by class of service:

Class of Service	Adult Revenue Passengers		Percent Change
	1965	1975	
Transbay (Inc. Rte. T)	10,287,930	2,309,764	— 77.5%
Express	2,639,385	2,331,870	— 11.7
Arterial	18,757,275	25,461,045	+ 35.7
Crosstown & Feeder	3,994,845	13,132,535	+228.7
TOTAL	35,679,435	43,235,214	+ 21.2%

Both of the express operations, transbay and East Bay, are expected to decline materially; these are long-haul intercity services. Offsetting that, the arterial routes modified to serve BARTD stations, as well as the crosstown and feeder routes, are expected to rise by 36% and 229%, respectively. The aggregate effect, as shown in the foregoing table, is a 21% projected increase in traffic but for considerably shorter distances.

Under the recommended plan, more than one-half of AC Transit patronage in 1975 will be BARTD-related. The relationship of AC Transit and BARTD as complementary services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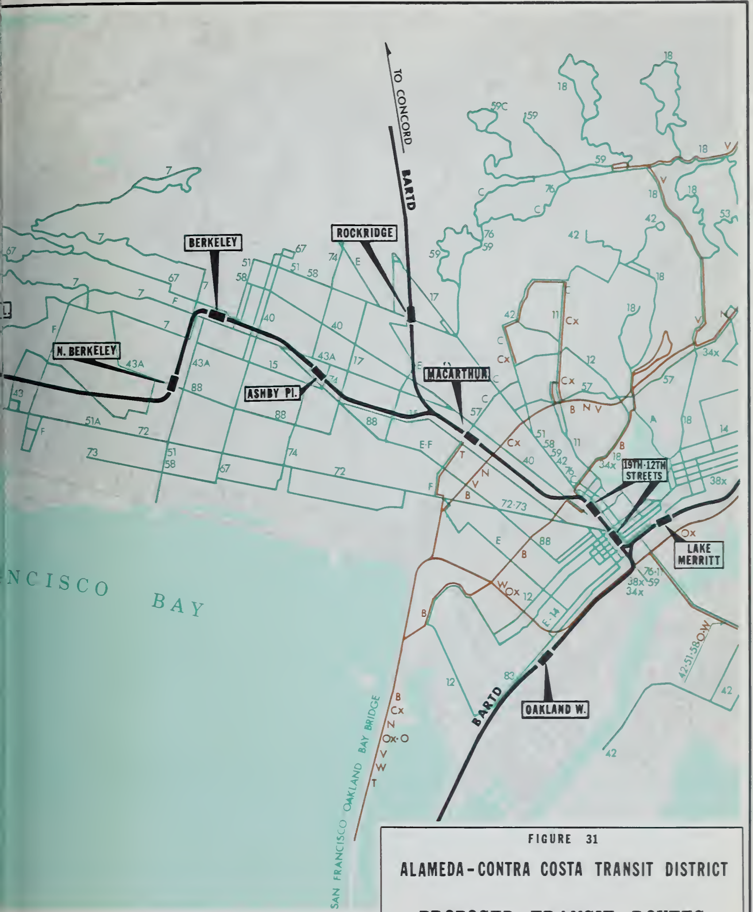


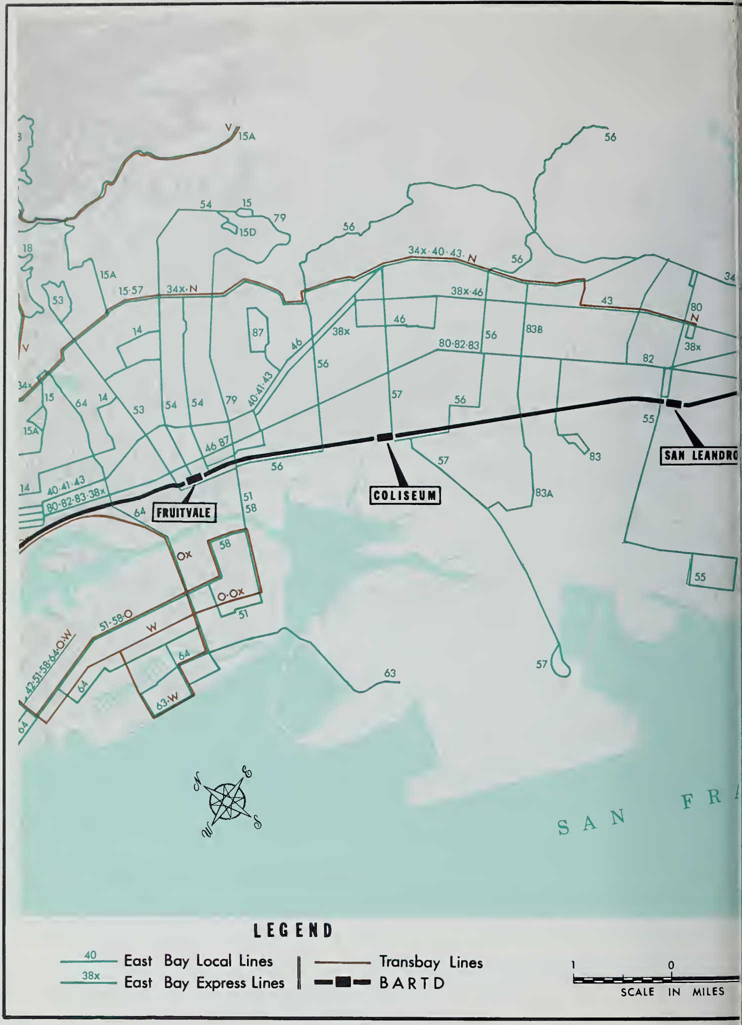
FIGURE 31

ALAMEDA-CONTRA COSTA TRANSIT DISTRICT

PROPOSED TRANSIT ROUTES

NORTHERN SERVICE AREA

SIMPSON & CURTIN SAN FRANCISCO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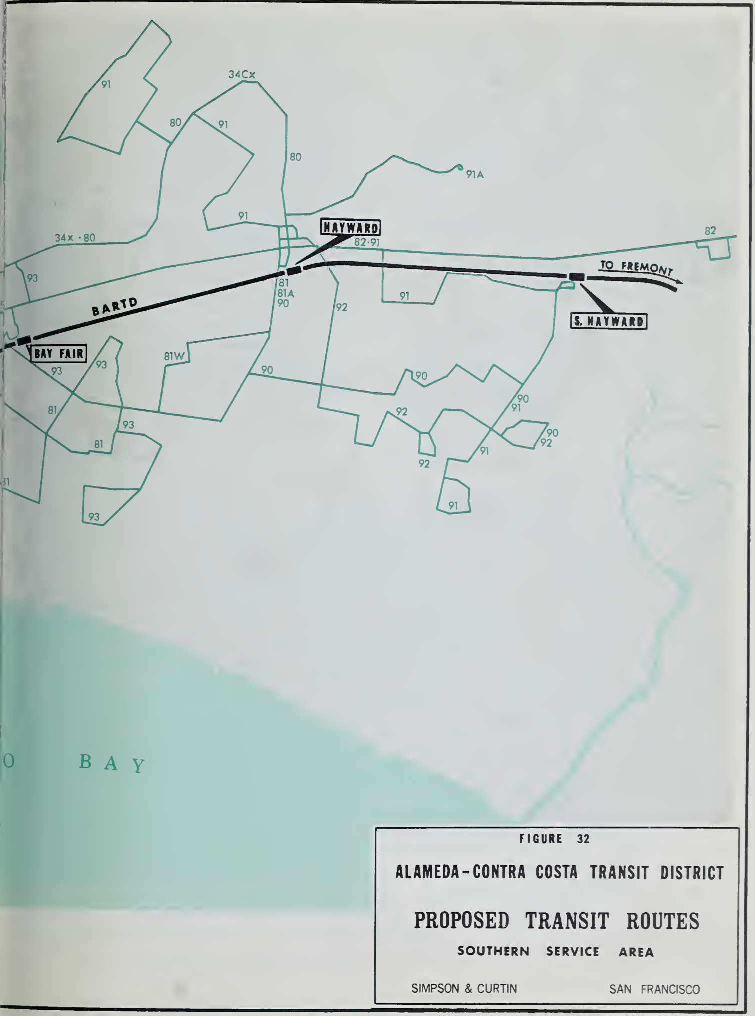

FIGURE 32

ALAMEDA-CONTRA COSTA TRANSIT DISTRICT

PROPOSED TRANSIT ROUTES

SOUTHERN SERVICE AREA

SIMPSON & CURTIN SAN FRANCISCO

is summarized in the following split of AC Transit traffic between surface journeys and joint trips using surface and BARTD:

Class of Service	1975 Adult Revenue Passengers			Percent BARTD-Related
	Surface	Surface-BARTD	Total	
Transbay	1,878,559	431,205	2,309,764	18.7%
Express	1,002,345	1,329,525	2,331,870	57.0
Arterial	11,109,300	14,351,745	25,461,045	56.0
Crosstown & Feeder	4,623,840	8,508,695	13,132,535	64.8
TOTAL	18,614,044	24,621,170	43,235,214	56.9%

The proportion of AC Transit traffic which will be BARTD-related in 1975 varies from 19% on the remaining transbay bus routes to 65% on the proposed crosstown and feeder routes. In fact, all three forms of AC Transit operation in the East Bay—express, arterial and crosstown and feeder—will carry more than one-half of their passengers either to or from a BARTD station. Needless to add, the significance of effective passenger interchange—physically and fare-wise—cannot be made more evident.

SAN FRANCISCO TEST NETWORKS

The Muni route system will be substantially altered by BARTD, although not to the same degree as AC Transit. In addition to coordination with BARTD, there are several other missions to be accomplished in the Muni route system analysis:

- Define other corridors for rapid transit development.
- Test approximately 50 route extensions, additions and other service requests submitted by various organizations and individuals in San Francisco to the Public Utilities Commission.
- Develop other route changes, unrelated to BARTD, for improving the Muni system and optimizing transit use.

These objectives are part of the city's overall transit goal stated effectively and concisely by Mayor Shelley: 20 minutes transit travel time from home to work for all San Franciscans. The city's configuration, as well as its travel patterns, make this a challenging, albeit attainable, goal.

Four complete transit systems affecting most, if not all, of the 61 operating routes,[8] were developed and tested for San Francisco to arrive at a plan of optimum transit usage. In each of these, some grade-separated service has been included in addition to BARTD running diagonally across the city to its southwestern corner. Even if no changes are made, present committed plans for BARTD provide for streetcar routes along Market Street in the heart of downtown San Francisco to be transferred below grade to a surface-subway operation. Further than this, corridor volumes developed in the origin-destination study indicated a need for more than merely a rearrangement of surface routes to solve the problems of coordinated transit travel. Existing transit volumes in the Richmond, Sunset and Twin Peaks corridors reveal a distinct need for high-speed, grade-separated transit facilities. As a result, in all of the test networks, high-speed rapid transit in a variety of forms was evaluated in these areas.

San Francisco Plan A

The first layout incorporated a design of feeder surface routes connecting to rapid transit trunks—a so-called 'feeder-trunk' design. Under this Plan A, the emphasis was placed on rerouting surface lines to connect rapid transit stations, testing an operating philosophy adopted by Toronto Transit Commission in developing its newly built rapid transit system. The trunk lines consisted of:

(a) The BARTD Mission line.
(b) A grade-separated rapid transit line from Davis Street to St. Francis Circle, replacing the Twin Peaks streetcar lines on Market Street and beyond.
(c) Sunset Tunnel extended west to Irving Street and Arguello Boulevard.
(d) A grade-separated high-speed facility in the Richmond corridor along Post Street and Geary Boulevard between Market Street and 45th Avenue (Figures 33 and 34).

Surface route changes were designed to feed these rapid transit lines to the maximum degree feasible. Most competing through routes were eliminated or converted to rapid transit feeders. Existing crosstown and feeder routes were extended to rapid transit stations.

Two short extensions were made to the cable car lines, one to provide more direct service to

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[8] The number of operating routes differs from the 53 routes used in Chapter 4 which were combined for accounting purposes.

Fisherman's Wharf and another to connect with the proposed Embarcadero Plaza at Market Street and the Embarcadero.

Additional and improved express bus service in the Bayview and Marina corridors was included in the plan.

In total, 10 of the present Muni routes were eliminated, 11 modified to feed BARTD, 15 changed to serve other Muni rapid transit lines, 11 modified for service improvements unrelated to rapid transit and 14 remained unchanged.

Several measures were evaluated under Plan A, including passenger attraction, speed of operation, safety and service reliability; these are considered later in conjunction with Plan B.

San Francisco Plan B

A completely opposite arrangement for transit routes was tested as Plan B. In this design, the emphasis was placed on 'through routes' with as little transferring as possible. Most existing lines to downtown San Francisco, as well as other through routes connecting major sections of the city, were continued.

The only completely grade-separated high-speed facility under Plan B was BARTD. Other grade-separated routes were established to provide expedited service in the more congested areas by rerouting surface vehicles below grade to subway operation. Under this plan, existing streetcar lines were continued below the street surface from the Twin Peaks Tunnel to their downtown terminal at the foot of Market Street. Likewise, a grade-separated Post Street 'busway' (Figure 35) was provided for the downtown trunk leg of surface vehicles in the Richmond corridor. This grade-separated busway extended from California and Montgomery Streets along Post Street and Geary Boulevard to Masonic Avenue. Another busway was provided by extending the Sunset Tunnel west to Irving Street and Arguello Boulevard and converting it to joint bus and streetcar operation,

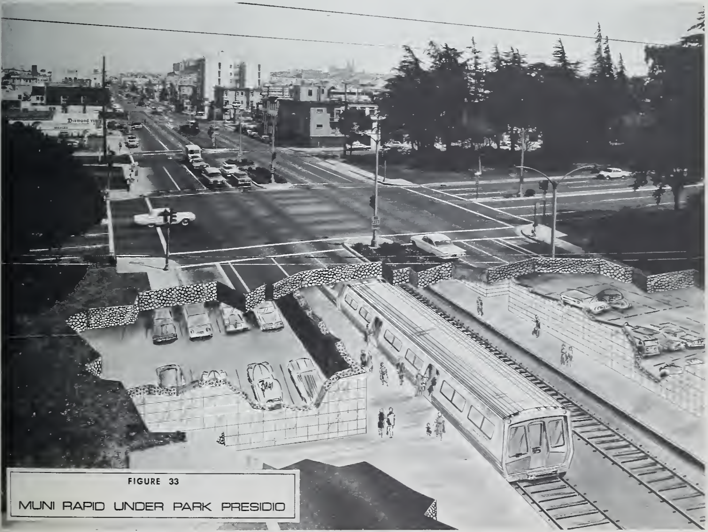


FIGURE 33

MUNI RAPID UNDER PARK PRESIDIO

serving the Judah streetcar line and several bus lines in the Sunset corridor.

Various other changes unrelated to BARTD and rapid transit operation were made, including those proposed by local agencies and individuals for service betterments in various parts of the city.

In several instances, crosstown and feeder routes were modified to serve BARTD, in a fashion similar to Plan A. For the most part, however, surface arterial routes to the CBD, bus as well as streetcar, were left unchanged.

Altogether, Plan B consisted of 11 routes adjusted to serve BARTD, eight lines rerouted into the Geary-Post Busway, 13 changed to provide service improvements unrelated to rapid transit, 18 Muni routes unchanged and 11 routes eliminated.

Evaluation of Test Plans A and B

The overall results from tests of these two functional designs in transit routing revealed a greater passenger attraction and superior service under Plan A—the 'feeder-trunk' design. 16,200 peak hour travelers were attracted to rapid transit under Plan A; this was 21.5% more than the volume drawn to comparable through routes under the Plan B design. On the other hand, more than 10% greater use was made of surface coach vehicles under Plan B, as shown in Table 46.

Table 46

ESTIMATED PASSENGER VOLUMES
AT MAXIMUM LOAD POINTS
MUNI TEST PLANS A AND B

	1975 Peak Hour—Peak Direction Volume	
Type of Service	Plan A	Plan B
Motor Coach	18,570	21,155
Trolley Coach	12,790	13,520
Rapid Transit		
Route J	530	425
Richmond	8,120	—
Post St. Busway	—	5,695
Sunset	3,720	3,800
Twin Peaks	3,830	3,410
Subtotal—Rapid Transit	16,200	13,330

In the Richmond corridor, which is the most heavily traveled-by-transit section of the city, a high-speed, grade-separated facility as contemplated under Plan A was distinctly superior. This attracted 8,100 peak hour travelers, compared with 5,700 prospective transit riders using a subway-surface operation. The busway has the advantage of being able to use the same bus equipment on regular routes for residential pickup and delivery with fast access to downtown stations via the underground facility. However, cost studies indicated that this advantage was outweighed by more costly structure needed for turn-around of buses and provisions of ventilation for exhaust fumes. These structural and mechanical considerations, together with the lesser passenger volume attraction, led to elimination of the busway concept.

In the Twin Peaks corridor, fully grade-separated rapid transit had a somewhat higher passenger attraction than streetcars in subway-surface operation (Table 46), although the difference was not too substantial. Here again, factors other than passenger volume revealed rapid transit to be the more feasible service from standpoints of safety and reliability of operations.

> *Where street cars* are operated both on surface and below grade, headways between vehicles are not dependable inasmuch as they are a function of peak hour traffic congestion for the surface portion of the service. This characteristic is particularly significant during rush hours where the combination of street traffic and the need for close headways cause a progressive deterioration in the transition from surface to private right-of-way—scheduled speed is reduced accordingly.
>
> *In Boston*, with both types of service, the average speed achieved on streetcar routes in subway-surface operation is 58% of that for fully grade-separated rapid transit lines.
>
> *Philadelphia* is another city with subway-surface streetcar operations on Market Street running parallel to rapid transit service. Average speed of the subway-surface streetcar routes is less than 70% of the rapid system and schedule reliability is correspondingly lower, particularly in peak hours when street congestion is heaviest.
>
> *This lack* of travel time dependability is underscored in San Francisco by present

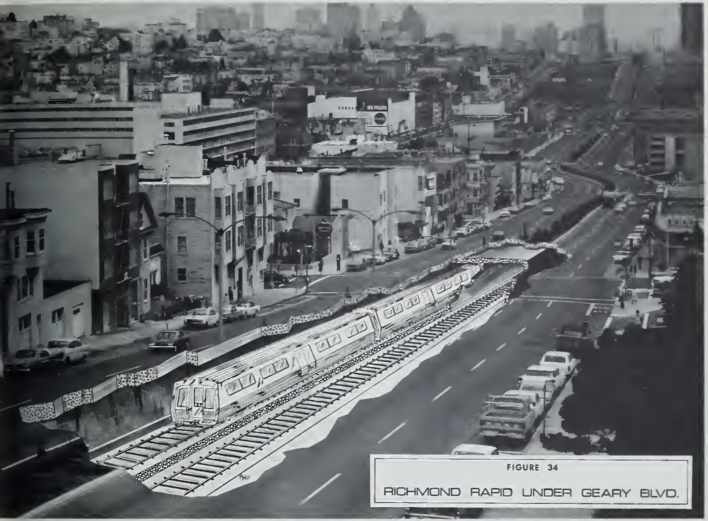


FIGURE 34

RICHMOND RAPID UNDER GEARY BLVD.

peak and off-peak running times on Muni streetcar routes:

Round-trip running time

Rte.	A.M. Peak	Midday	P.M. Peak
J	66 min.	57½ min.	67 min.
K	85 min.	79 min.	84 min.
L	97 min.	87 min.	92 min.
M	97 min.	91½ min.	98 min.
N	95 min.	77½ min.	92 min.

Despite the fact that these streetcars have separate right-of-way for a major part of the route, traffic congestion in peak hours results in 20% greater travel time than during midday.

The loss of peak period speed from the combination of surface and off-street operation is complicated further by the fact that five streetcar routes would be required to merge into a single grade-separated facility under Market Street. Minimum safe headway for subway operation at high speeds is 90 seconds. Placing this restraint on the Market Street trunk service, it became evident that the five lines merging into one at a minimum spacing of 90 seconds would result in each line operating at an average 7½-minute headway. This would be a considerably lower quality service than presently is being operated on the streetcar lines at grade.

A further operating complication for the Market Street subway-surface proposal revealed problems associated with physical merging of three streetcar lines into a single track. This merger involved not only a distinct slowdown in operating speed to execute the merge, but also presented a substantial risk in making right and left turns across 'opposite direction' tracks in the tunnel.

Subway-surface operation has the distinct advantage of providing "one-vehicle" service to downtown. Previous studies have indicated that this is a prime consideration in the development of increased riding volume, especially from previous auto users. The one form of 'rapid transit' which has demonstrated successful capability in many cities is the freeway express bus. Its principal virtue is providing door-to-door service to riders from points convenient to them—not the system. The use of streetcars for Sunset and Twin Peaks Rapid also has the advantage of affording an easy construction transition, in that present Muni equipment could be utilized with new subway-surface cars "phased in" as capital becomes available.

San Francisco Plan C

Plan C was designed to incorporate the more attractive segments of Plans A and B, including the expanded rapid transit system.

Surface routes competing with rapid transit lines were eliminated or modified to provide local service between stations. Crosstown and feeder routes were changed to directly serve the rapid transit stations and additional crosstown service was added by extension of existing routes and some new routes.

Under Plan C, the rapid transit network included the following:

(a) The BARTD Mission line.

(b) A grade-separated rapid transit facility in the Market Street-Twin Peaks corridor from Davis and Market Streets, extending beyond St. Francis Circle to San Francisco State College at 19th and Holloway Avenues.

(c) A grade-separated rapid transit facility in the Sunset corridor between Market and Davis Streets and 19th Avenue and Irving Street, closely paralleling the existing "N" streetcar line.

(d) A grade-separated rapid transit line in the Richmond corridor as described under Plan A.

Express bus and local route improvements in the Bayview and Marina corridors, as well as cable car extensions were the same as Plans A and B.

This plan contemplated revisions of 48 routes —12 to be eliminated, 11 modified to serve BARTD, 14 changed to feed Muni Rapid and 11 modified to improve service not related to rapid transit. Thirteen routes remained unchanged.

The effect of this plan was to reveal a slight gain over Plan A in passenger attraction and a significant improvement upon Plan B. In overall terms, Plan C resulted in a 20% increase in transit riding over 1965 levels.

Recommended Network for San Francisco

The network recommended for San Francisco is a refinement of Plan C, reflecting operational changes desired by Muni management for smoothness of operation and some further service adjustments for passenger convenience.

The heart of the recommended network (Plan D) is a four-prong network of rapid transit lines from the southern and western residential sections of the city to downtown San Francisco:

Richmond Rapid—A rapid transit line under Post Street and Geary Boulevard extending from Market and Montgomery Streets to 45th Avenue. This alignment would not only serve the Outer Richmond, Richmond and Western Addition districts but also provide a future connection for BARTD to Marin County.

Sunset Rapid—A rail rapid transit line under Market Street, branching west at Duboce Avenue, continuing through Sunset Tunnel and beyond to 19th Avenue.

Twin Peaks Rapid—Subway under Market Street with connection to Twin Peaks Tunnel, then continuing to St. Francis Circle as provided for under BARTD construction program. It is proposed to extend this line further south past Stonestown to San Francisco State College.

Mission (BARTD)—The rapid transit facility soon to be constructed by BARTD under Market Street, continuing down Mission Street and Southern Freeway to Daly City.

In addition to these proposed rail rapid transit lines, improved bus rapid service is contemplated for those sections of the city not directly served by rail facilities. For example, the Bayview corridor would be accommodated with additional express service using buses over the James Lick Freeway and the Southern-Embarcadero Freeway, as well as the Hunter's Point Freeway, when completed.

Altogether, the recommended plan includes a network of 54 surface routes, as illustrated on Figure 36.

New crosstown routes between the Bayview and Mission corridors are proposed. These routes would make direct connection with the BARTD Mission line and some would continue crosstown to the Twin Peaks area. Through-routing to the north side of Market Street of additional routes from the southern part of the city is planned, along with the extension of existing crosstown routes into areas of the Bayview corridor not now served.

Route 6 would be extended from Market Street to Treasure Island via the Embarcadero Freeway and the Bay Bridge.

In the Marina corridor, express service on Route 41 to downtown is planned. Other routes will be extended to Fisherman's Wharf and some existing local routes modified to provide more direct service.

Under this high-speed network, most of the Muni surface transit system will be rerouted to provide fast and direct connections to rapid transit trunk lines in each corridor. Several existing crosstown routes and some arterial surface routes will be retained to accommodate intermediate travel.

As illustrated in Figure 36, 12 of the existing Muni routes would be modified to serve as BARTD feeders while 17 are rerouted to feed Muni Rapid lines. Under the proposed system, 13 other Muni routes would remain unchanged and 12 would be modified for service improvements unrelated to rapid transit plans.

Total adult riding on Muni surface routes under the coordinated plan is expected to approach 150 million annual users from a 1965 level of 126 million adult riders—a gain of 17%. The change in the distribution of riders by type of service in 1965 and 1975 is illustrated by the following comparison:

	Adult Revenue Passengers		
Type of Service	1965	1975	Percent Change
Streetcars	18,952,305	—	—100.0%
Cable Cars	7,437,814	9,944,357	+ 33.7
Trolley Coach	43,931,913	30,440,058	— 30.7
Motor Coach	55,314,946	106,403,099	+ 92.4
TOTAL	125,636,978	146,787,514	+ 16.8%

The lack of streetcar riders in 1975 is, of course, attributable to the rapid transit proposals. If, on the other hand, streetcar operations are continued, there will be a corresponding decline in Muni Rapid patronage as reviewed below. Motor coach riding shows a substantial increase partially due to the conversion of all trolley coaches except Routes 1, 3, 22, 30, 41 and 47 to motor coach operation.

Under the recommended plan, 60% of the total Muni surface patronage will be "rapid-related" in 1975. The relationship of Muni surface, Muni Rapid and BARTD as complementary service is pointed up by the percentage distribution of Muni patronage—39.8% ride Muni surface, 30.9% use Muni surface for the connect trip to Muni Rapid and 29.3% use Muni surface to reach the BARTD line. Here again, the significance of effective passenger interchange between Muni and BARTD is evident.

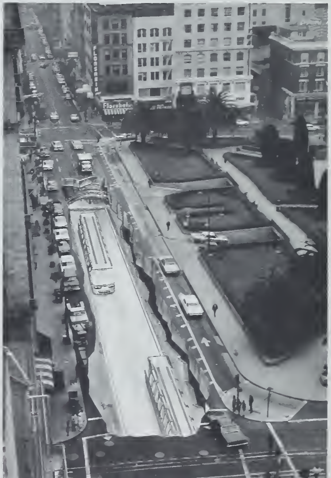
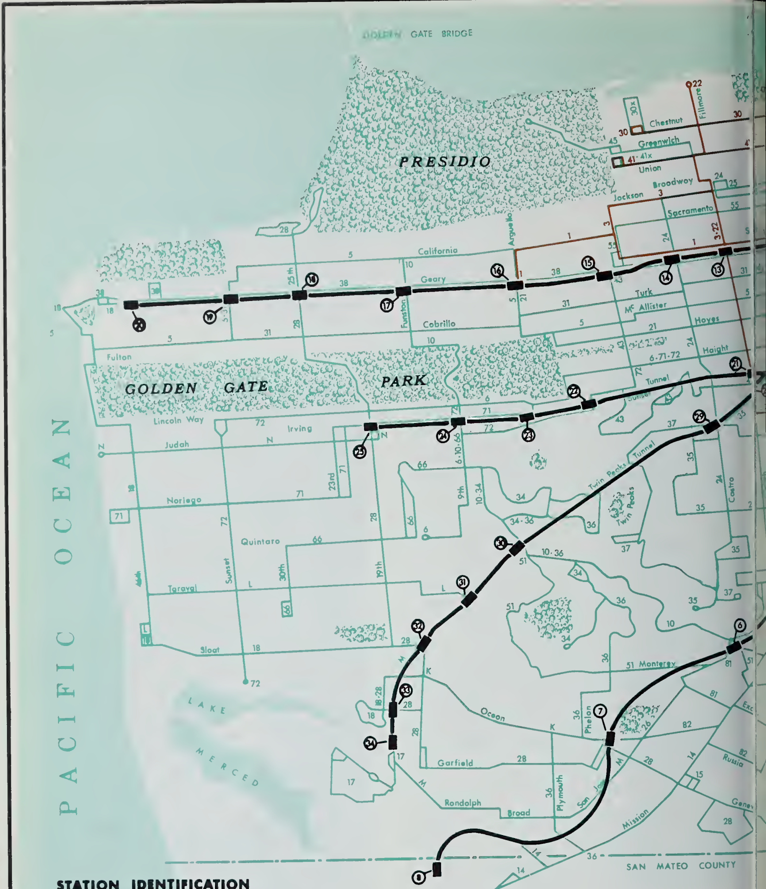


FIGURE 35

POST BUSWAY AT UNION SQUARE



STATION IDENTIFICATION

BARTD

1-Montgomery
2-Powell
3-Civic Center
4-16th St.
5-24th St.
6-Glen Park
7-Balboa
8-Daly City

RICHMOND RAPID

9-Montgomery-Kearney
10-Stockton
11-Jones-Leavenworth
12-Van Ness
13-Fillmore
14-Divisadero
15-Masonic
16-Arguello
17-Park Presidio
18-25th Ave.
19-33rd Ave.
20-45th Ave.

SUNSET RAPID

21-Church
22-Carl
23-A
24-9
25-19

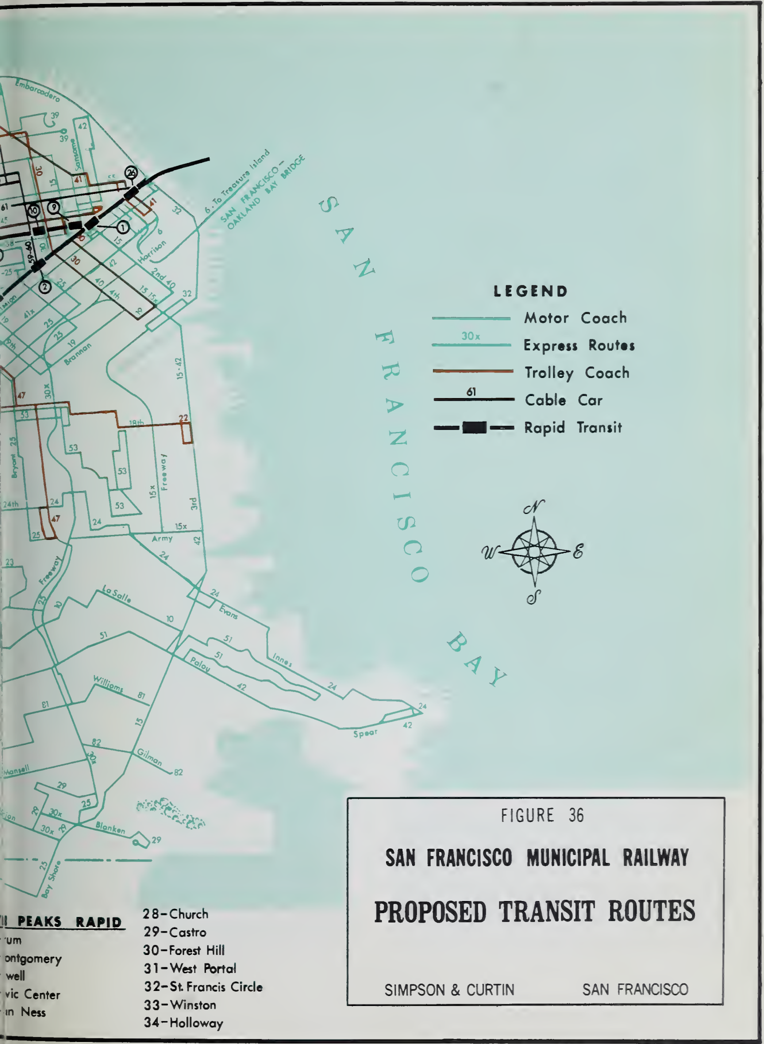


FIGURE 36

SAN FRANCISCO MUNICIPAL RAILWAY

PROPOSED TRANSIT ROUTES

SIMPSON & CURTIN SAN FRANCISCO

Table 47

1975 STATION TRAFFIC ON PROPOSED RICHMOND RAPID TRANSIT LINE
(Adult Riders Prior to Adjustment for Fare Differentials)

	Total Boarding and Alighting			
Station	Productions (Home End)	Attractions (Non-home End)	Total	Percent Productions
45th Avenue	11,301	985	12,286	92.0%
35th Avenue	4,787	1,180	5,967	80.2
25th Avenue	7,998	751	8,749	91.4
Park Presidio	3,163	634	3,797	83.3
Arguello	16,844	2,973	19,817	85.0
Masonic	12,310	2,224	14,534	84.7
Divisadero	7,715	943	8,658	89.1
Fillmore	4,650	3,884	8,534	54.5
Van Ness	4,269	11,204	15,473	27.6
Leavenworth	11,762	13,541	25,303	46.5
Stockton	13,274	27,584	40,858	32.5
Montgomery	12,947	45,117	58,064	22.3
TOTAL	111,020	111,020	222,040	50.0%

Muni Rapid Transit Riding under Recommended Plan

Much of the projected 22% increase in transit use in San Francisco is attributable to improved service offered by the proposed network of Muni Rapid lines. As pointed out on Table 41, passenger projections anticipate almost 200,000 Muni Rapid rides daily—more than one-half the total Muni patronage.

Daily Muni Rapid adult riding will be subdivided among the three major lines as follows:

Sunset Rapid	25,340
Twin Peaks Rapid	19,223
Market Street (both lines)	43,367
Subtotal	87,930
Richmond Rapid	111,020
TOTAL	198,950[9]

Figure 37 illustrates the "between station" volumes resulting from this overall rapid transit usage. The radial nature of transit travel is once more underscored by the build-up of volumes from the ends of lines yielding maximum loads at entrances to the San Francisco CBD. The maximum load point on the Richmond Rapid occurs in downtown San Francisco between the Leavenworth and Stockton Stations—more than 45,000 trips per day will pass through this heaviest section of the projected rapid transit line. The Sunset and Twin Peaks rapid facilities achieve maximum volumes immediately west of Van Ness Avenue.

Station Usage. The projected station traffic on proposed Muni Rapid lines in 1975 is shown on Tables 47 and 48. Important stations on the Richmond Rapid in residential districts include 45th Avenue, Arguello Boulevard and Masonic Street. The heavily used downtown stations will be Leavenworth, Stockton and Montgomery Streets. Table 47 shows the breakdown between production and attraction trip ends at each of the 12 stations on this proposed rapid transit route as input for station layout and design.

The Sunset Rapid and Twin Peaks Rapid would converge on a common subway under Market Street in downtown San Francisco. Heaviest among the five stations in the Sunset Rapid would be 19th Avenue, due to the convergence of feeder buses. The Twin Peaks Rapid would have uniformly distributed traffic among

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[9] This total use represents the yield from the coordinated network prior to adjustments for the effect of differential rates of fare on competitive surface routes. These adjustments for the influence of alternative fare plans—BARTD, Muni Rapid and Muni surface—are reviewed in detail in Simpson & Curtin, *Technical Memorandum No. 53: Fare Plans, Passenger and Revenue Projections,* November, 1966.

Table 48

1975 STATION TRAFFIC ON PROPOSED SUNSET AND
TWIN PEAKS RAPID TRANSIT LINES
(Adult Riders Prior to Adjustment for Fare Differentials)

	Total Boarding and Alighting			
Station	Productions (Home End)	Attractions (Non-home End)	Total	Percent Production
Sunset Rapid				
19th Avenue	23,538	1,864	25,402	92.7%
9th Avenue	6,333	377	6,710	94.4
Arguello	4,036	1,475	5,511	73.2
Cole	4,624	659	5,283	87.5
Church	4,093	3,681	7,774	52.6
Subtotal	42,624	8,056	50,680	84.1
Twin Peaks Rapid				
San Francisco State	4,117	1,238	5,355	76.9
Winston	319	439	758	42.1
St. Francis Circle	2,654	602	3,256	81.5
West Portal	5,891	1,501	7,392	79.7
Forest Hills	4,879	1,251	6,130	79.6
Castro	7,184	667	7,851	91.5
Church	4,296	3,407	7,703	55.8
Subtotal	29,340	9,105	38,445	76.3
Common Stations (Both Lines)				
Van Ness	8,791	8,128	16,919	52.0
Civic Center	1,658	9,057	10,715	15.5
Powell	2,156	15,791	17,947	12.0
Montgomery	2,756	22,716	25,472	10.8
Embarcadero	604	15,076	15,680	3.9
Subtotal	15,965	70,768	86,733	18.4
TOTAL	87,929	87,929	175,858	50.0%

its seven stations except for low prospective volume at Winston Avenue. The five stations serving downtown San Francisco from Van Ness Avenue to the Embarcadero in the section common to both of these lines would all accommodate substantial volumes with heavy emphasis on attraction end of journeys.

As in the case of BARTD and the Richmond Rapid, the Montgomery Station would be the heaviest on the system for Twin Peaks and Sunset Rapid Transit lines. From these several analyses, it becomes increasingly evident that the transit hub of the entire Bay Area is centered at the intersection of Market and Montgomery Streets.

Population Served by Rapid Transit. Under the recommended plan for coordinated transit in San Francisco, one-fifth of the city's population will be within easy walking distance of rail rapid transit (Table 49). Another three-fifths will have short feeder bus access to rapid transit lines connecting directly with the commercial and shopping areas and Civic Center of downtown San Francisco. This rail rapid

Table 49

POPULATION SERVED BY RAPID TRANSIT COMPREHENSIVE TRANSIT PLAN FOR SAN FRANCISCO

Facility	Population Served: Within Walking Distance	Population Served: With Feeder Bus Access	Population Served: Total	Percent of City Population Served
Richmond Rapid	56,785	79,919	136,704	18.1%
Sunset Rapid	29,294	60,348	89,642	11.9
Twin Peaks Rapid	33,715	48,514	82,229	10.9
Mission (BARTD)	28,825	278,870	307,695	26.4
Central Business Area	23,789	57,764	81,553	10.8
TOTAL (a)	172,408	525,415	697,823	78.1%

(a) Includes 3,325 persons within walking distance, 104,675 with feeder bus access and a total of 108,000 persons served in San Mateo County.

Table 50

RUNNING TIMES FOR RAPID TRANSIT LINES COMPREHENSIVE TRANSIT PLAN FOR SAN FRANCISCO

Route	No. of Stations	Length to CBD (Powell St.) Miles	Operating Speed: Maximum m.p.h.	Operating Speed: Average m.p.h.	Running Time: Present Minutes	Running Time: Rapid Transit Minutes	Gain in Running Time
Richmond Rapid	11	5.45	28	24	25.9	13.8	47%
Sunset Rapid	9	4.32	37	21	20.9	12.6	40%
Twin Peaks Rapid	9	5.55	41	22	31.5	13.5	57%
Mission (BARTD)	7	7.10	46	31	26.7	13.9	48%

transit network, serving nearly four-fifths of the city's total population, will provide San Francisco with a higher proportion of rapid transit service to its downtown core than any other metropolitan center in the Western Hemisphere.

Improved Travel Time. Running times from the outer ends of proposed rapid transit routes to downtown San Francisco will be shortened 40% to 57%, as shown on Table 50. Time savings will vary from 8 to 18 minutes each way, compared with present street transit service. Transit commuters in San Francisco, therefore, will save 15 to 35 minutes daily.

With rapid transit running times below 14 minutes from the outer ends of all four lines to downtown San Francisco, this recommended plan will bring about 95% of the city's population within Mayor Shelley's 20-minute goal.

It is evident from Table 50 that station spacing on these four rapid transit lines is the principal factor in overall speed of operations. With stations at approximately half-mile spacing on the three Muni Rapid lines, the average speed is in the range of 20 to 24 miles per hour. BARTD, however, will have stations about a mile apart in San Francisco, thus enabling an average operating speed of 31 miles per hour

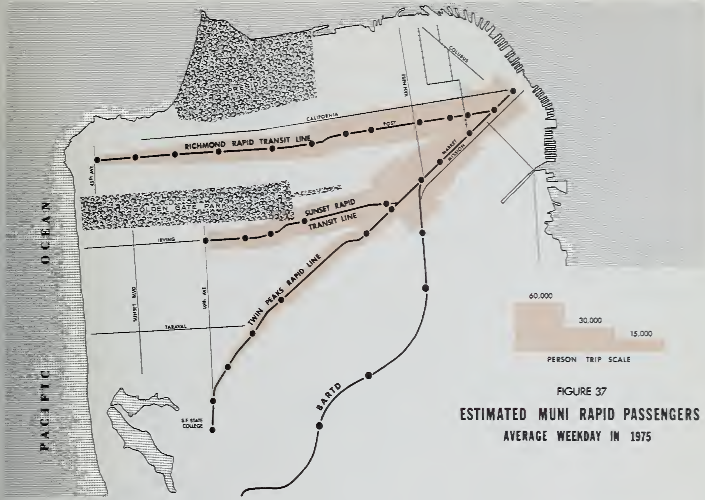


FIGURE 37

ESTIMATED MUNI RAPID PASSENGERS

AVERAGE WEEKDAY IN 1975

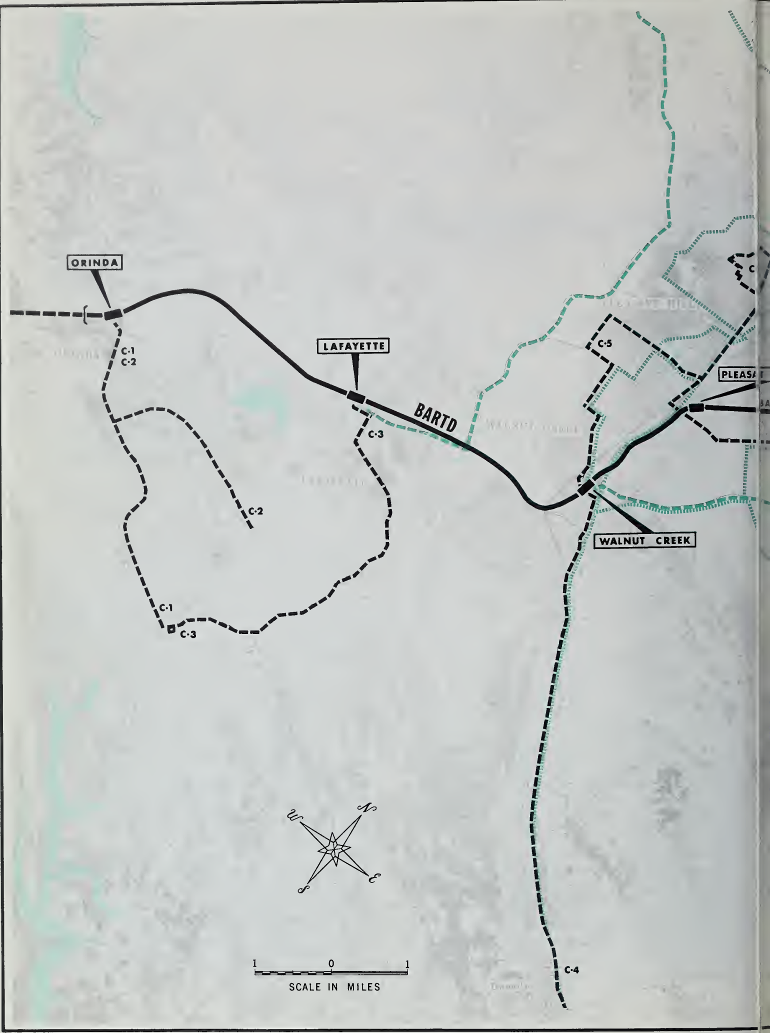
—nearly 50% higher than the Muni Rapid lines. Both operations will be a great improvement upon existing travel; surface routes in the same corridors now operate at 10 to 12 miles per hour.

FEEDER BUS OPERATIONS IN NEW SERVICE AREAS

Three portions of the periphery of the NCTDP study area lie beyond the service territories of AC Transit and Muni systems—eastern Contra Costa County, southern Alameda County below present AC Transit territory and northern San Mateo County. These have been investigated for feasibility of operating additional feeder bus service to the ends of BARTD lines.

For the most part, these areas are comprised of a group of suburban residential communities with older cities at the ends of the BARTD lines blending industrial activity, commercial development and residential land use. Pittsburg and Antioch in Contra Costa County and Livermore-Pleasanton in southern Alameda County are essentially self-contained communities, with only minor transportation ties to the San Francisco-Oakland urban area.

In eastern Contra Costa County, the BARTD Concord line will extend some 16 miles east of the present AC Transit territory. Five BARTD stations on the Concord line will be outside the AC Transit service area. The average spacing between these stations is approximately two and one-half miles, with the widest spacing being 4.2 miles. Several factors will limit station accessibility in this area and contribute to the need for feeder buses. Residential development is of low density. A very small proportion of potential BARTD riders will be within reasonable walking distance of the rapid transit stations in this area. Those few patrons who might walk to the station will be inconvenienced by the fact that the BARTD line parallels or is in the median of a freeway for a considerable distance. The line will be difficult to reach by walking except where there are nearby under- or overpasses. Although it is planned to provide a total of 6,050 parking spaces at the outer five BARTD stations on the Concord line—autos will be the major access mode—many persons


ORINDA
C-1
C-2
LAFAYETTE
BARTD
C-3
C-2
C-1
C-3
C-5
PLEAS
WALNUT CREEK
C-4
N
W
E
S
1
0
1
SCALE IN MILES

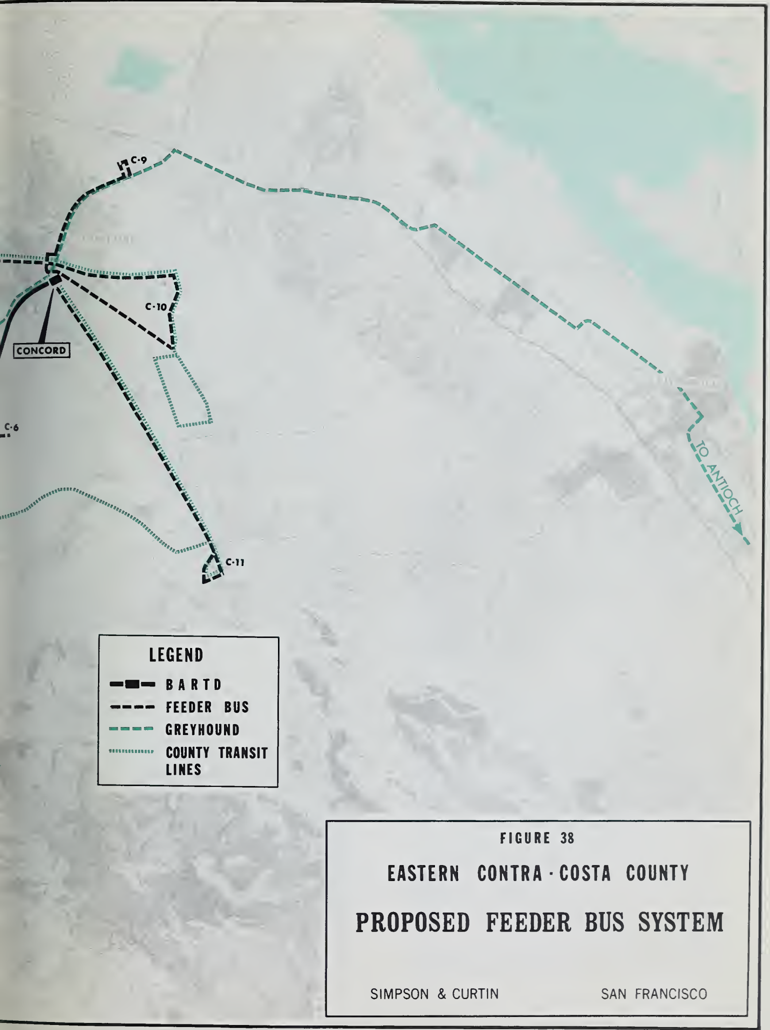


FIGURE 38

EASTERN CONTRA-COSTA COUNTY

PROPOSED FEEDER BUS SYSTEM

SIMPSON & CURTIN SAN FRANCISCO

may be required, or desire, to use feeder buses. The long distance between stations is also a factor contributing to the need for feeder bus service.

In southern Alameda County, two BARTD stations will be located along six miles of rapid transit line lying south of the present AC Transit service area. The factors noted above for eastern Contra Costa County will contribute also to the need for feeder bus service in this area. The only significant difference is that the BARTD alignment parallels a railroad in southern Alameda County rather than a freeway as on the Concord leg.

The situation in northern San Mateo County is somewhat different. Only one BARTD station, Daly City, is involved, and the Daly City area is already served by a network of bus routes. In addition, a transportation needs study is currently being conducted by the West Bay Rapid Transit Authority. This study could result in the further extension of rapid transit into the county or in a network of surface transit routes providing greater area coverage than at present.

All three areas now have local carriers or Greyhound, or both, to accommodate their local service needs. The question is: how much added service is warranted to provide suitable connections to BARTD? The revenue/cost relationship for bus operation is a restraint in this respect. However, with the introduction of rapid transit, it may be in the public interest to operate feeder buses at a loss in some instances in order to encourage maximum use of the rapid transit service.

Some guidelines are appropriate, however, in order to maintain such loss operations within reasonable proportions. If not so limited, the cost could easily become a burden out of proportion to the patronage attracted. In testing these new feeder routes, an economic evaluation was made on the basis of anticipated routes under the warrants established by the National Committee on Urban Transportation for new feeder bus routes, as follows:

> The estimated passenger revenue produced by the new or extended service must equal or exceed the estimated out-of-pocket cost of operation of the extension, to warrant an actual 90-day "terminable" trial. To justify continuation of the extension, the actual passenger revenue produced in the last 30 days of the trial period must equal or exceed the actual out-of-pocket operating cost.

This guideline was the product of studies by recognized transit experts and published by the Public Administration Service in their Procedure Manual.[10]

As a practical matter, feeder bus service should be limited to areas within a short distance of a rapid transit station to permit a reasonable level of service with a minimum number of vehicles. Since suburban service is primarily geared to the demands of the commuter, hours of operation should be confined to those periods necessary to meet that demand.

For the new routes being considered in these three outlying areas, the following service standards were developed:

> Coverage—The service area of feeder bus routes should be within six or seven miles of the BARTD line.
>
> Hours of Service—Service should be provided during those hours which coincide with the riding pattern on the rapid transit system. Normally, this would be for a period of about four hours around both the A.M. and P.M. peaks on weekdays only.
>
> Level of Service—A headway of 20 to 30 minutes should be applied in order to provide a reasonably attractive level of service.

Feeder Bus Routes in Eastern Contra Costa County

Eastern Contra Costa County comprises approximately 250 square miles of low density population clusters. Average density for this portion of the county is only 1.7 persons per acre. However, a few centers such as Concord develop densities upwards of 10 to 20 persons per acre.

Immediately east of the Berkeley Hills are the communities of Orinda and Lafayette, located along Highway Route 24 which parallels the BARTD line. Both of these communities consist of small commercial centers with adjacent residential areas of single-family homes developed on rugged topography, resulting in a sparse pattern of residential development.

Further east along Route 24 are the fast-growing cities of Walnut Creek, Pleasant Hill and Concord which are located on relatively flat terrain and contain sizable residential and commercial areas. Concord, the largest city along this leg of BARTD, has a residential population of 76,000 and a well-developed commercial core.

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[10] Public Administration Service, *Recommended Standards, Warrants, and Objectives for Transit Service and Facilities.*

Beyond this group of cities is a string of older communities to the north and east along the inland waterways. Antioch, Pittsburg, Port Chicago and Martinez are separated from the remainder of Contra Costa County by extensive open areas, a range of rugged hills and a large military reservation.

A network of 11 additional routes was designed to serve the five BARTD stations in eastern Contra Costa County and to provide local service within the major communities. In addition, it was assumed that existing Greyhound routes would continue in operation between the BARTD stations and the more distant outlying communities. Each feeder route is laid out to operate between the residential and commercial areas of adjacent communities and the closest BARTD station. The routes and their service areas are illustrated on Figure 38.

The recommended feeder network does not include service to areas more distant than about seven miles from the BARTD line. Service to communities beyond that distance cannot be justified not only from a cost point of view, but also because the demand for service just is not there. To the extent that outlying communities such as Antioch, Pittsburg and Martinez require a connection with BARTD, that service is already provided by existing carriers.

This would also be true of communities where feeder service is proposed. If, at the time BARTD begins operating, local transit service is already being provided and it is coordinated with BARTD, then the scope of the proposed system can be correspondingly reduced.

Feeder Bus Routes in Southern Alameda County

Southern Alameda County includes two new BARTD stations—Union City and Fremont—which extend six miles beyond the present AC Transit territory. Fremont, Newark and Union City comprise the service territory for these stations and have a combined population of approximately 122,000 persons. Fremont, the largest of the three (population 88,400), is a recently incorporated city embracing several small, older communities and large new residential tracts. In land area, it is the third largest city in California—trailing Los Angeles and San Diego. Rapid population growth is projected for this area with increases of 92% in Fremont, 82% in Newark and nearly 100% in Union City.

The remainder of southern Alameda County is centered around the communities of Livermore and Pleasanton, east of the Sunol Ridge. The primary activities in this section of the county are agriculture and quarrying. The major centers of population of this section of the county are about 20 miles east of the BARTD line.

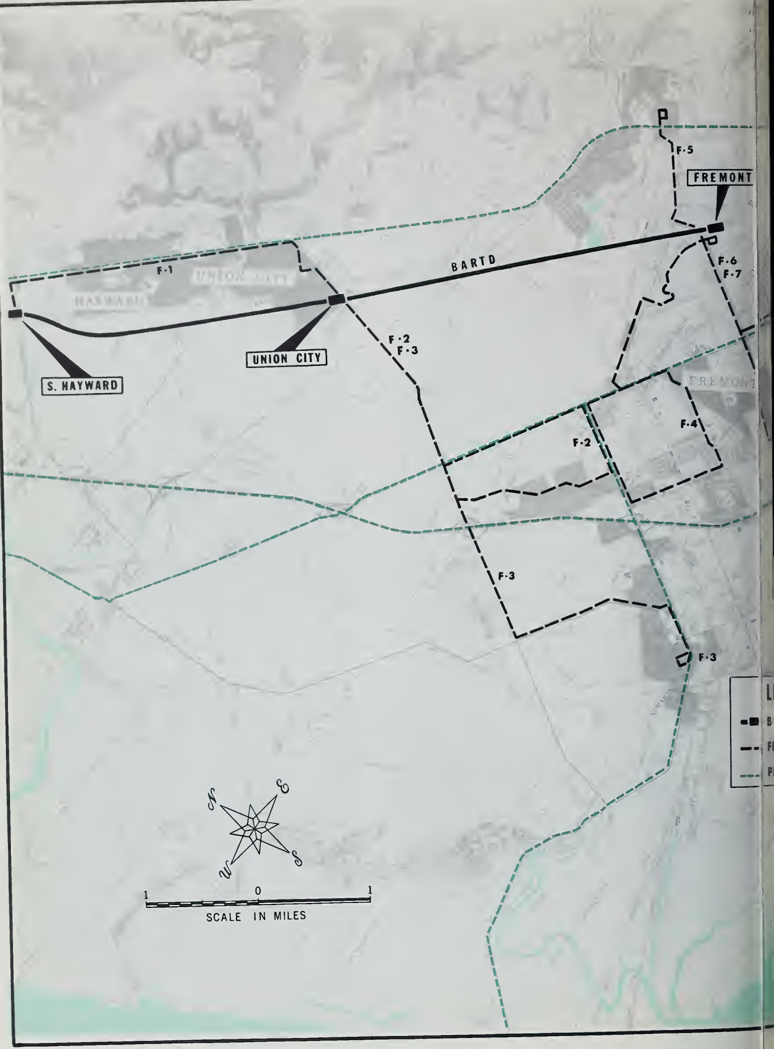
Transit service in southern Alameda County is currently provided by Peerless Stages, an intercity carrier operating between Santa Cruz, San Jose and Oakland. Service is provided on a "flag stop" basis on main roadways.

A network of seven feeder routes has been designed to serve the portion of the BARTD line in southern Alameda County beyond the AC Transit service district. The routes will serve the BARTD South Hayward, Union City and Fremont stations from those communities, as shown on Figure 39.

This feeder network will provide service to that part of southern Alameda County west of the Sunol Ridge and will be supplemented by routes of Peerless Stages now operating in the same area. Service beyond this point cannot be justified from either the standpoint of costs or service demand. Until such time as the area between Livermore-Pleasanton and the East Bay develops, there is no need for transit service beyond that which now exists.

Feeder Bus Routes in Northern San Mateo County

Northern San Mateo County will be served by the BARTD Daly City Station. This area is presently served by Northgate Transit Company and Western Greyhound Lines. Greyhound operates three routes between Pacifica, San Bruno, Colma and Daly City to San Francisco. Northgate Transit provides local service over a network of five routes in Daly City, Colma and South San Francisco. In 1965, Northgate Transit operated 15 buses and carried 393,252 passengers. These routes, if properly coordinated with BARTD, should fill the need for feeder bus service until such time as the comprehensive transportation plan for San Mateo County presently under study by the West Bay Rapid Transit District develops a transit network supplementary to BARTD service in Daly City.


F·5
FREMONT
F·1
BARTD
F·6
F·7
HAYWARD
UNION CITY
F·2
F·3
UNION CITY
S. HAYWARD
FREMONT
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SCALE IN MILES

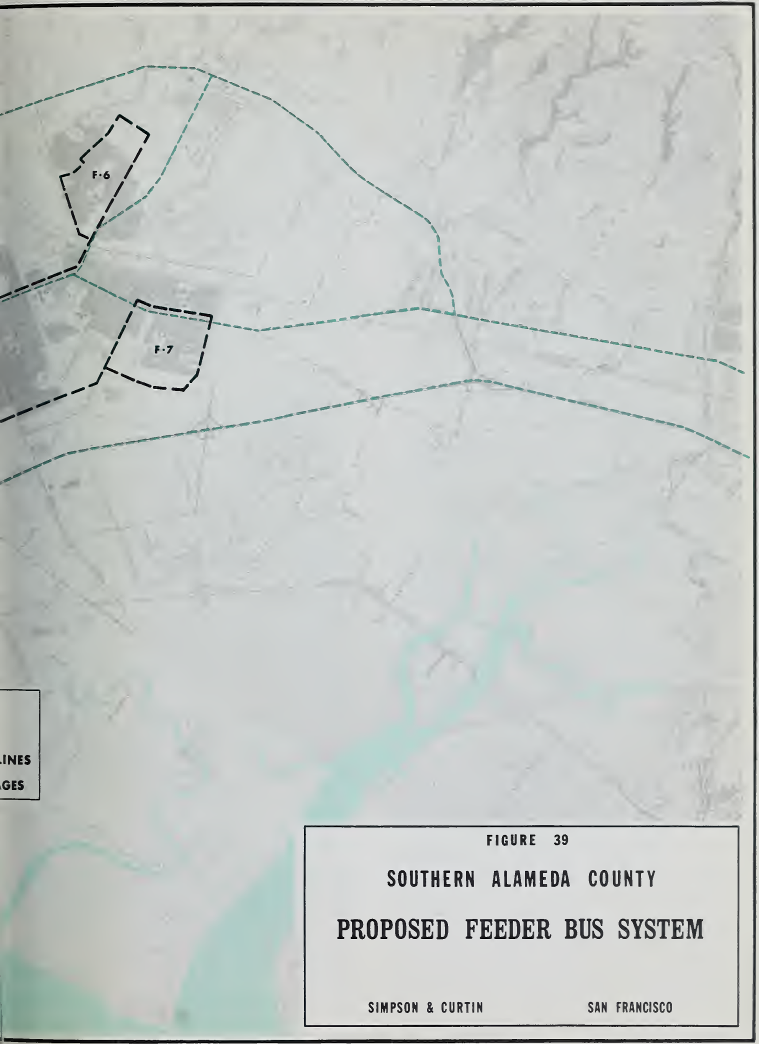

FIGURE 39

SOUTHERN ALAMEDA COUNTY

PROPOSED FEEDER BUS SYSTEM

SIMPSON & CURTIN SAN FRANCISCO

CHAPTER 11

Future Needs-Vehicles, Plant & Manpower

EIGHT out of every ten transit patrons in 1975 will be required either to use a different bus route, one with a different destination, or a rapid transit train which they have not yet seen, in order to make the same journey as in 1965. This is the substance of the route changes and traffic projections for the 1965-1975 decade developed in the preceding chapter (Chapter 10). It is evident that this transformation will require more change than just route configurations; substantial modifications of the fleets, physical plants and manpower of both AC Transit and Muni will similarly be involved.

AC Transit Fleet

AC Transit is an all-bus operation and will remain so for the foreseeable future. The system now comprises 685 coaches which are distributed among its three East Bay operating divisions.

Mid-1965 assignment of coaches to regular route service for morning and evening peak operations was as follows:

	A.M. Peak	P.M. Peak
Transbay	236	228
East Bay		
Express	47	52
Local	284	282
TOTAL	567	562

This vehicle assignment did not include coaches used primarily on school trips or vehicles for special services. These requirements, plus a normal complement of spares and coaches undergoing repair, comprised the balance of approximately 120 vehicles.

As pointed out in the preceding chapter, the redistribution of traffic with BARTD in operation will substantially alter peak vehicle requirements in the AC Transit system. It is expected that AC Transit will only need 65% of its regular route fleet to handle future surface operations in the East Bay in 1975, as follows:

	Buses in Daily Service		
	1965	1975	% Change
Transbay	236	47	—80.1%
East Bay			
Express	47	36	—23.4
Local	284	286	+ 1.0
TOTAL	567	369	—34.9%

Reduction of transbay service from 16 to six routes with lesser service on those being continued will permit an 80% reduction in transbay coaches down to 47 vehicles in 1975. Correspondingly, East Bay express service requirements will drop from 47 to 36 vehicles. On local routes, however, peak vehicle needs will increase slightly in order to meet the primary function of these routes as feeders to BARTD.

With further allowance for coaches to be used in school and special services, as well as spares, it is likely that the AC Transit system will comprise a fleet of approximately 500 coaches in 1975.

No consideration has been given to possible expansion of AC Transit services beyond its present service area; if future expansion should become a reality, this estimate of 500 coaches would be increased accordingly.

Muni Vehicle Requirements

The vehicle requirements of Muni are more difficult to assess, not only by reason of rapid transit and other route changes, but also because of equipment needs to overcome present deficiencies and the prospects for conversion of some existing vehicle types. As previously pointed out, the Muni fleet comprises four classes of vehicles, three of which are no longer being built.

Muni has a total fleet of 983 vehicles available for service, 833 of which are required to fill the demand for scheduled service in the P.M. peak, as follows:

	Vehicles in Daily Service	
	A.M. Peak	P.M. Peak
Streetcars	100	93
Cable Cars	16	26
Trolley Coaches	271	292
Motor Coaches	435	422
TOTAL	822	833

As in the case of AC Transit, requirements vary among vehicle types for morning and evening peak service. On Muni, maximum streetcar and motor bus needs occur in the morning peak, while the greater number of cable cars and trolley coaches are on the street in the evening rush hour.

The recommended Muni plan for 1975 will change materially the present fleet composition. Three new rapid transit lines are proposed, requiring the addition of 104 new high-platform rapid transit cars to the system in place of streetcars. Further, four of the present 15 trolley coach routes will be converted to bus operation, and five routes eliminated with an accompanying reduction of nearly two-thirds the number of trolley coaches. Despite a substantial gain in passenger riding, a 24% reduction in peak vehicle needs to an active daily fleet of 635 vehicles is projected for Muni operations in 1975.

	Vehicles in Daily Peak Service		
	1965	1975	% Change
Streetcars	93	—	—100.0%
Cable Cars	26	31	+ 19.2
Trolley Coaches	292	97	— 66.8
Motor Coaches	422	403	— 4.5
Rapid Transit Cars	—	104	—
TOTAL	833	635	— 23.8%

The rapid transit cars will not only replace the five existing streetcar lines in the Twin Peaks and Sunset corridors, but they also will furnish rapid transit in the Richmond corridor. These vehicles would be modern, high-platform cars with advanced styling and every travel convenience—comparable to the proposed BARTD vehicles (Figure 40).

This recommendation was made by Kaiser Engineers following detailed studies of three types of dual-rail equipment—(1) existing PCC-type streetcars, (2) articulated streetcars, and (3) high-platform rapid transit cars. It was determined that comparative operation of the proposed systems favored the use of rapid transit cars in multiple unit trains. Systems capacity can be increased for rapid transit service by longer trains, which is not possible where streetcars operate partially or wholly in surface traffic. Multiple-unit operation provides economy in reduction of operating personnel, greater ultilization of equipment from increased speed of operations, and safety in operating conditions. Rapid transit cars are therefore recommended for their superiority in greater capacity, proven experience, and compatibility with structures of the existing Twin Peaks Tunnel and new Market Street Subway.

Five additional cable cars will be required. Equal pains will be taken to assure that these are as antiquated as the rapid transit cars are modern, in keeping with the present cable car fleet.

Reduction in trolley coach operation will be accomplished by retirement of most of these vehicles currently in operation, utilizing available parts and other items salvaged for rebuilding and improvement of the trolley coaches remaining.

The number of motor buses needed in 1975 will be only slightly less than 1965 coach requirements. However, due to the age of the present fleet, a complete turnover of equipment in this category is needed. Actually, the Muni system will need approximately 600 new motor coaches between now and 1975 to provide not only for the feeder and crosstown lines contemplated under this recommended plan, but also to accommodate school, special and other services that are not part of regular route operations considered herein.

AC Transit System

AC Transit will require some capital expenditures to modify its shop and garage facilities for the curtailed fleet projected for 1975. The three East Bay garages will require alteration as follows:

Division #2—This depot now accommodates 248 coaches, as well as the central transportation, purchasing, stores and maintenance facilities. Under projected operations in 1975, the number of coaches operating from this location would be reduced; some reduction in demand will be desirable since the present transportation accommodations—offices, operators' rooms, cashier facilities, etc.—are quite cramped. More efficient space could also be utilized by the maintenance department.

If, on the other hand, it becomes expedient to maintain Division #2 at its present operating capacity due to curtailed activities at Division #3, some major alterations in the present transportation and mechanical layout of Division 2 should be programmed.

The maintenance building would have to be extended and a new inspection pit added and another structure built to accommodate the present welding shop and stores for upholstery, tires and other lesser-used items now stored in shacks. A rearrangement of entrance facilities for better coach circulation within the depot would also be desirable. The order of magnitude for these changes is estimated at $400,000.

Division #3—This depot will be substantially reduced in size when BARTD becomes operational for two reasons: (1) the BARTD station in Richmond requires a substantial portion of land now occupied by the Division 3 garage, resulting in the demolition of certain facilities; and (2) prospective elimination of transbay bus routes from the Richmond area and substantial modification of East Bay routes will reduce the number of buses at this division and alter considerably the future need for garage facilities.

Preliminary site and operational studies are being made by AC Transit management to determine the future service needs for the reduced fleet at this depot. Several alternatives might be considered: a smaller operating and maintenance base can be reconstructed on the remaining parcel after the BARTD station-taking. With a BARTD station nearby, this land may have a higher and better use, in which event the smaller bus depot would be relocated to another site with lesser prospects for commercial or high-rise residential development.

A further consideration is the fact that full garage facilities are hardly warranted for a fleet of less than 100 coaches; it would seem preferable to transfer all maintenance work for lines operating out of Division 3 to the more complete facilities in Division 2, continuing Division 3 as an 'outpost' or satellite depot, with only the minimum dispatching and storage accommodations. This would strike a balance between the added deadhead mileage resulting from transfer of activities to Division 2 and the cost of maintaining a supervisory and garage force at the Richmond location.

More detailed study of the several alternatives is necessary in order to provide even an order of magnitude figure for the capital expenditures involved. Obviously, the trade-off in land values under the foregoing alternatives would be taken into account, as well as the cost for maintenance facilities to be constructed.

Division #4—This depot is projected for a reduction in coaches when BARTD is fully operational in 1975. No problems of plant facilities are contemplated by this. However, if Division 3 is reduced to a satellite depot with its maintenance activities transferred to Division 2, there would be merit in considering the relocation of some lines from Division 2 to Division 4. In this event, the southernmost depot would be continued at or close to its existing capacity. Some improvement in maintenance and operating facilities would be warranted in such an event, the cost of which is estimated to be quite nominal.

MUNI MODERNIZATION PROGRAM

The improvements in Muni plant and facilities needed to achieve the recommended system for 1975 will involve major rehabilitation of existing shop and garage facilities and the addition of substantial new way and structures, aggregating more than $300 million. This program of Muni modernization has been developed under the following major categories:

- Vehicles
- Way and Structures
- Shops and Garages
- Cable Car System
- Power System
- Special Facilities

The vehicle replacement program for the recommended operation in 1975 already has been reviewed. Several alternatives for staging this program, which involves replacement of virtually every vehicle in the present fleet, have been considered, including a 'first-phase' program which was the subject of a local bond issue in November, 1966. Before reviewing the development phases, it is advisable to describe in greater detail the various other elements of the total modernization program.

Way and Structures

Foremost elements of the comprehensive transit plan for San Francisco are the three additional rapid transit lines from the southern and western residential sections of the city to downtown San Francisco, supplementing the BARTD line which is being built diagonally across San Francisco from Daly City to and through the downtown area:

Richmond Rapid—Under one concept, a two-lane tunnel with eight stations along Post Street and Geary Boulevard to Masonic Avenue was considered, with access ramps at Van Ness and Masonic, for a total length of 3.39 miles. This required an extensive fume exhaust and ventilation system, together with multiple passing lanes and loading platforms in stations.

A subway-aerial concept also was considered for the Richmond corridor, similar to the all-subway type just reviewed, except that sections of aerial structure would be provided in the median strip of Geary Boulevard, beyond Masonic Avenue. This would amount to 2.0 miles of subway and 3.85 miles of aerial structure. Rolling stock would be rapid transit cars, with articulated streetcars as a feasible alternative.

The way and structure for the Richmond corridor in the recommended plan consists of a double track rail tunnel with 12 stations under Post Street and Geary Boulevard, extending from Market and Montgomery Streets to 45th Avenue—a distance of 5.85 miles. This alignment would be designed not only to serve the outer Richmond, Richmond and Western Addition districts, but also include provision for future connection of BARTD to Marin County. The facility would be designed to accommodate high-platform rail transit vehicles in tunnel over the entire route.

The subway-aerial structure would be the cheapest to construct—$120 million. Next in dollar magnitude was the busway with an estimated capital cost of $197 million. Both of these structures present serious objections from operating and aesthetic viewpoints. The recommended way and structures—the all-subway operation from Montgomery Street to 45th Avenue—has an estimated capital cost of $221 million.

Twin Peaks Rapid—The major portion of this facility is already provided for. BARTD will construct the subway under Market Street with connections to the Twin Peaks Tunnel, then extend the tunnel to St. Francis Circle. Under the recommended plan, it is proposed to extend this line farther south past the Stonestown Shopping Center to San Francisco State College and Parkmerced. With renovation of Twin Peaks Tunnel, this would bring the entire Twin Peaks line up to optimum capability for rapid transit service at a fraction of the cost for reconstructing it new. The line would be adaptable to fast-operating, high-platform rapid transit cars, or articulated streetcars as an alternative.

Captital cost for this way and structures would be $4¾ million for Twin Peaks Tunnel renovation and $23.6 million for extension of the line to San Francisco State College.

Sunset Corridor—Improved transit service to the Sunset district would be accomplished in two stages. Initially, the present streetcar tunnel used by the Judah line would be renovated, with paving, ventilation, lighting and tiling to accommodate express bus service now running in a congested throat between Market Street and Arguello Boulevard. Thereafter, a new rail tunnel parallel to the existing facility would be constructed as a subway with five stations between the Market Street Subway and a terminal station at 19th Avenue on Irving Street, a distance of 3.0 miles. As previously discussed under route configurations for the recommended plan, bus lines serving the Sunset district would feed the end of this facility at 19th Avenue. This rapid transit facility would be similar to the Twin Peaks and Richmond Subway in cross-section, with provision for extension farther into the Sunset district at a future date.

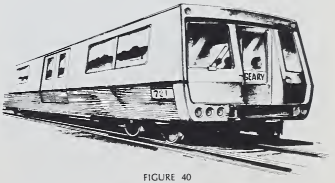

FIGURE 40
CONCEPT OF MUNI RAPID CAR

Capital cost of up-grading the existing tunnel for bus operations would be $3.6 million, while building the new rapid transit subway would aggregate another $86.2 million.

Shops and Garages

Without any consideration of rapid transit or service improvement, rebuilding the existing shops and garage facilities of Muni is urgently needed. Some existing facilities can be salvaged; for the most part, however, the Muni properties are so completely worn and outmoded that reconstruction is the only economic course. A summary of rehabilitation and new construction recommended at each division is as follows:

- Kirkland Motor Coach Division requires new garage and office facilities to replace existing ones restricted by poor circulation and property utilization.
- Ocean Motor Coach Division would be provided with a new two-level bus storage and service facility on the site of the present complex for rail car shops and barn at Ocean-Geneva-Elkton, made available by relocation of rail service to the new Twin Peaks Subway.
- Potrero Motor Coach Division requires modification to the existing adequate structure for conversion to motor coach service from present trolley coach use.
- Presidio Trolley Coach Division needs improvements to existing facilities, and refurbishing of Muni General Offices with new partitions, fenestration, flooring, lighting and Geary Street entrance with elevators.
- Automotive Overhaul Shop at 24th and Utah should be provided with a new double deck structure for enlargement of overhaul, body and paint shops, parts store room, automotive equipment offices and parking, and demolition of the present inadequate building.
- New Rail Service Facility would be located in an underground installation with storage yard, servicing, repair and overhaul and offices adjacent to the Twin Peaks Subway for maintenance of rapid transit equipment, superseding antiquated rail service facilities at the Elkton-Geneva complex.

Estimated capital costs for shop and garage rehabilitation are $17.3 million.

Cable Car System

A program for restoration and rehabilitation of the cable car facilities has been developed to maximize the attractiveness of these quaint vehicles, which are world-renowned as the hallmark of the city of San Francisco.

- Improvements to way, structures and equipment, including partial rerailing, and alarms, signals and braking systems for increased safety and efficiency.
- Restoration of cable car barn including a visitors' gallery, museum, and displays, to enhance historical value.
- Line extensions providing short additions on the Powell-Mason and California lines.
- Additional cable cars, consisting of five new Powell type units, to augment inadequate fleet in peak traffic.

Capital costs of this cable car rehabilitation program are estimated at $2.8 million.

Power System

An analysis of the existing power system and the requirements to accommodate the proposed rapid transit and remaining trolley coach operations was made by the Machinery/Systems Group of FMC Corporation.

The proposed reduction of trolley coach lines and eventual elimination of streetcars will decrease future load requirements of the various existing substations, particularly the Bryant, Richmond, and Turk Substations. The proposed Richmond rapid transit line would require five new substations and associated equipment. When this system is installed, the trolley coach lines serviced by the PG&E substations would be supplied by the rapid transit substations. In addition, the Sunset rapid transit line would require two substations and associated equipment.

The recommended electrification equipment for the Twin Peaks rapid transit line would be of solid state rectifier type substations for the Market Street Subway and the substations in the Twin Peaks Tunnel and extension stations. The present Twin Peaks Substation would be retained and the 750 kw (Outer Mission) substation would be relocated to supply power for the new rapid transit railcar facility. This electrified system would utilize a third rail for supplying power to rapid transit trains.

The electrical equipment selected for the rail rapid transit line is of the most modern service-proven components available with the exception of the third rail which is presently being evaluated by BARTD. The substation packages are of the silicon rectifier type which contain the necessary A.C. and D.C. switchgear, transformers, etc. The substations can be placed in tunnel vaults or in the proposed passenger stations.

Estimated capital cost for the proposed power system amounts to $5.6 million.

Special Facilities

Added capital facilities are recommended for passenger amenities and to improve the operating efficiency of the comprehensive transit system for San Francisco:

Speedwalks—Electric walkways for passenger distribution from Market Street stations to the financial district, major department stores and to Civic Center.

Minibus—Loop routes using side-loading Minibuses between heavy transit generators in the downtown area.

Radio-Telemetry Control—A two-way radio system for tracking and communicating with rapid transit and surface vehicles on each route. This will permit feeder routes to be slowed or held for effective meets with rapid transit and other arterial lines, as well as tighter supervision of on-time service.

Park-Ride—An underground garage accommodating 2,500-3,500 vehicles is proposed under Park Presidio to intercept Marin motorists and switch them to the Richmond Rapid. A combination all-day parking and all-day transit ticket would be sold at prices competitive with downtown parking.

Further park-ride installations would be considered at outer terminals of other rapid transit lines, notably under Golden Gate Park and Southern Embarcadero Freeway.

Traffic Priorities—Bus-actuated traffic signals on arterial routes, no-parking restrictions, lengthened bus stops, center lane bus operation on Market Street are among the surface priorities sought for transit to speed up street operations.

Bus Shelters—Attractive shelters, with direct telephone connections to transit information center, are proposed at heavy street loading points for passenger accommodation.

The radio and telemetry control system is estimated at a capital cost of $1 million; other items remain unpriced pending more complete development of these concepts.

First Phase Program

In order to initiate progress on the more critically needed parts of this comprehensive transit plan, a first phase program of capital improvements aggregating $96.5 million was placed before the San Francisco electorate in November, 1966. This program consisted primarily of new buses, shop and garage rebuilding, cable car rehabilitation, and up-grading the Twin Peaks rapid transit line to take advantage of the BARTD construction program. The bond issue received approval of 58% of the voters, representing a favorable disposition towards the program but not sufficient plurality to carry the issue. Under the San Francisco charter, two-thirds endorsement is necessary for acceptance of any capital improvement program.

Certain items of the overall program may be secured without public referendum—new buses, radio equipment, cable car rebuilding, etc. However, for the major elements such as the rapid transit facilities, a resubmission to the voters will most likely be required.

The comprehensive program of transit improvements is estimated to aggregate $310 million to $395 million, depending upon which of several alternatives are finally chosen. The program is designed for eligibility for federal aid under the Mass Transportation Act, although it is unlikely that federal moneys will be available for all phases of it.

AC TRANSIT BUSES IN LOCAL AND EXPRESS SERVICE

FUTURE MANPOWER NEEDS

The NCTDP work program does not contemplate route-by-route schedule cutting of the service anticipated under the recommended plan. Since labor contract work-rule provisions are the major element in schedule cutting, and these are difficult to predict, any attempt at this time to develop detailed scheduling of service in 1975 would be of doubtful value. In the absence of actual operating schedules, existing relationships between service levels and manpower requirements have been established and used as the basis for future projections. The fact that the level of service provided in relation to demand under the coordinated system is essentially the same as that provided by the existing systems supports the validity of the method.[1] In essence, the miles and hours of service provided in the proposed plan for 1975 represent a continuation of the quality of service presently provided by AC Transit and by Muni.

AC Transit Manpower Requirements

In October of the base year, 1965, AC Transit reported a total of 1,416 employees divided into the following classifications:

Hourly Rated:	
Operators	957
Maintenance	206
Salaried:	253
Total	1,416

The level of service for the year totalled 22,719,481 vehicle miles and 1,637,680 vehicle hours, yielding a manpower index of 1,711 vehicle hours per operator. Under the proposed plan, hours of service will total 1.7 million. This would indicate a need for approximately 1,000 operators based on the same productivity. However, with the elimination of 90% of transbay service, it should be possible to achieve a more efficient utilization of operators than at present. A total of 975 operators is therefore projected under the recommended plan.

The maintenance and servicing functions are related to the number of miles operated and to number of vehicles. This group totalled 206 employees in 1965, of whom some 120 were mechanics, 66 were service employees and the remainder building maintenance and stores personnel. In the base year, approximately 189,000 vehicle miles per mechanic were operated. Application of this ratio to the 20.3 million miles projected under the coordinated system indicates a force of 107 mechanics—a reduction of 13 men from 1965.

The force of 66 service employees was required in relation to peak vehicle requirements of 567 buses. Peak vehicle requirements are expected to drop 35% by 1975. However, when additional vehicles are included to provide school and other special service, the total number rises to 500. A proportionate reduction in the number of service employees would result in a requirement of 45 service personnel in 1975. No reduction has been projected in the number of building maintenance employees, but stores personnel have been reduced in the same proportion as service employees.

The administration and supervisory group totalled 253 employees in 1965. These included office personnel, street supervisors and ticket sellers at the Transbay Terminal. In view of the reduction in transbay service, an overall reduction in miles operated and in fleet requirements, a decrease in salaried personnel will be possible. For this purpose, a 10% reduction appears reasonable.

In summary, the manpower requirements for AC Transit under the coordinated system in 1975 compare with 1965 as follows:

	Number of Employees		
	1965	1975	% Change
Hourly Rated:			
Operators	957	975	+ 1.9%
Maintenance	206	168	—18.4
Salaried:	253	228	—10.0
Total	1,416	1,371	— 3.2%

The overall reduction in personnel is projected at only 3.2%. The number of operators required will be slightly higher, but offsetting reductions will be possible in other job classifications.

Muni Manpower Requirements

As of October 1965, the Muni work force totalled 2,738 employees, divided among the following categories:

Operators	1,763
Maintenance	599
Office & Miscellaneous	376
Total	2,738

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[1] Simpson & Curtin, *Technical Memorandum No. 42: Revenue and Cost Projection, 1975 Operating Results of Bay Area Transit Systems,* December, 1966.

As a result of the major changes proposed for the Muni system, several existing job classifications would be eliminated and some new ones created. A detailed study of individual job classifications would be necessary to determine the exact manpower requirements in 1975. For the purpose of this report, the procedure used for AC Transit, with appropriate adjustments for known differences, should be sufficient to assess the overall effect on manpower requirements.

In 1965, 1,763 Muni platform employees operated 2.8 million vehicle hours, or 1,588 hours per operator. Under the coordinated system in 1975, Muni surface lines are estimated to operate 3.3 million vehicle hours. Based on the 1965 relationship of operators to vehicle hours, this would require 2,078 operators.

Using a similar approach, 599 maintenance employees serviced the vehicles and facilities to provide 26.4 million vehicle miles in 1965. Surface vehicle miles are expected to increase 20% under the proposed plan; applying that increase to the 599 maintenance employees in 1965 results in a total of 720 in 1975.

Office and miscellaneous employees totalled 376 in 1965. Requirements for this group of employees should increase proportionately. In 1975, the number of operators will be up approximately 18% and maintenance personnel 20%. Therefore, a 20% increase has been applied to office and miscellaneous employees in 1975.

The remaining element of the Muni system in 1975 is the rapid transit network. Based upon the manpower requirements of the most comparable existing rapid transit systems, it is estimated that Muni Rapid would require approximately 400 operating and station personnel. Maintenance personnel requirements of the rapid transit system would be offset by the elimination of job classifications now required to service streetcars and trolley coaches so no additional adjustment has been made in the total number of maintenance employees required in 1975.

The net effect of the proposed plan in 1975 on total Muni manpower requirements will be an increase of approximately 33%, as shown in the table below:

	Number of Employees		
	1965	1975	% Increase
Operators	1,763	2,078	17.8%
Maintenance	599	720	20.0
Office	376	450	20.0
	2,738	3,248	18.6%
Rapid Transit	—	400	—
Total	2,738	3,648	33.2%

Although manpower requirements under the coordinated system in 1975 would be 33% higher in 1975, the corresponding increase in miles of service provided including rapid transit is 45%. Thus, under the coordinated system a higher volume of service will be provided by a lesser increase, proportionately, in manpower and vehicles, providing greater productivity as well as a more attractive system.

CHAPTER 12

Fares and Passenger Revenue in 1975

Relationships developed in prior chapters for the prediction of 1975 transit riding were calibrated from existing transit use, which is the product of the fare structures of the present carriers. Initial estimates of future travel, therefore, presuppose the continuation of existing fare policies. To the extent that alternative fare plans developed for 1975 will result in higher or lower fares than those presently existing for comparable journeys, it is necessary to alter transit travel to reflect travel costs.

Various alternate fare proposals were considered first from the standpoint of public acceptance and policy considerations, then tested for their influence upon traffic generation and revenue production. With several choices of fares on each of the three transit sytems—as well as inter-system alternatives and possible variations in parking charges—it is evident that 500 or more combinations could be devised. The initial problem was to narrow the choice to those which might have greater public appeal, then determine the effectiveness of components in attracting passengers and revenue. Following this, the cost side of the equation was introduced and the iterative process of revenue and cost projections repeated until a reasonable balance was achieved to satisfy fiscal requirements for the three transit systems.

Alternate Fare Plans Considered

As in the case of route configurations, several fare schedules for surface and rapid transit lines in the Bay Area were machine tested by bracketing the range of acceptable alternatives, then narrowing the choice within that range. The minimum fares examined were those now existing on Muni and AC Transit systems and the BARTD fare structure outlined in the BARTD Composite Report published in May, 1962.[1] At the other extreme, maximum fares were selected from consideration of prevailing levels among other carriers—Greyhound and Southern Pacific Railroad primarily—in the Bay Area.

BARTD Fare Plans—With respect to BARTD, four alternate fare plans were reviewed. Each of these four proposals has the same minimum and maximum fare, 25¢ and $1.00, respectively; the differences are in the block rate increases for trips of intermediate length. As shown on Figure 41, the incremental fare under Fare Plan B-1 for trips beyond 10 miles increases at a relatively uniform rate of about 2½¢ per mile in 5¢ multiples. Higher graduated increases for intermediate and longer trips are contemplated under the other fare proposals. Figure 42 illustrates the rate curve for BARTD Fare Plan B-4; the formula applied in determing these individual fares was as follows:

> Twenty-five cents basic fare for a four-mile BARTD trip.
>
> Twenty-five cents plus four cents per mile for a trip of four to 10 miles.
>
> Fifty cents plus three cents per mile for a trip of 10 to 15 miles.
>
> Sixty-five cents plus two cents per mile for a trip over 15 miles.

Again, fares have been rounded to the nearest 5¢ in applying this formula. On transbay trips, the individual trip mileage was used, plus four miles, with a 50¢ minimum.

AC Transit Fare Plans—Two alternatives were studied for the AC Transit system, as shown below. The first of these is the present

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[1] Parsons Brinckerhoff-Tudor-Bechtel *et al, op. cit.*

ALTERNATE FARE PLANS CONSIDERED FOR BARTD

	Plan B-1	Plan B-2	Plan B-3	Plan B-4
Minimum Adult Fare	25¢	25¢	25¢	25¢
Minimum Fare Applicable to Non-Transbay Trip of:	8 miles	8 miles	5 miles	4 miles
Maximum Adult Fare	$1.00	$1.00	$1.00	$1.00
Minimum Transbay Fare	35¢	50¢	50¢	50¢
Fare Increment for Transbay Trip	10¢	10¢	4 miles added	4 miles added
Adult Fare Within San Francisco	25¢	25¢	25¢	25¢
Maximum Fare on Peninsula (Daly City-San Francisco)	25¢	25¢	30¢	35¢

ALTERNATE FARE PLANS CONSIDERED FOR AC TRANSIT

	Plan A-1	Plan A-2
Adult Single Zone Cash Fare	25¢	25¢
Adult Token Fare	5/$1.00 (20¢)	None
Transfers	Free	Free
Minimum Transbay Fare—Cash/Commute	50¢/45¢	50¢/45¢
Surface Feeder to BARTD	10¢	25¢/Round Trip
Student and Child Fare	15¢	15¢

ALTERNATE FARE PLANS CONSIDERED FOR MUNI

	Plan M-1	Plan M-2	Plan M-3
Adult Surface Fare	15¢	20¢	25¢
Surface Transfers	Free	5¢ for first transfer only	Free
Adult Muni Rapid Fare	25¢	25¢	25¢
Adult Combination Surface-Rapid Fare	25¢	30¢	30¢
Surface Feeder to BARTD	5¢	10¢	25¢/Round Trip
Student and Child Fare	5¢	10¢	15¢

fare structure, with the addition of a 10¢ BARTD feeder fare. The second is a 25¢ minimum rate, with no token discount and half-rate for feeder trips to BARTD.

In addition to the specific fare schedules listed, consideration was given to revisions in the central zone limits on the AC Transit system, as well as to the potential of a revenue transfer and a change in the token rate to various levels between the present 20¢ and a flat 25¢ cash minimum with no discount.

Muni Fare Plans—Machine test runs for fares on the Muni system embraced three alternatives as summarized above.

Combination Fare Plans—Plans B-1 to B-4 inclusive were tested for the previously determined station-to-station volumes on the BARTD system, in combination with various feeder surface fares. Each of these tests involved separate consideration and subdivision of BARTD patronage among single-vehicle BARTD trips, then journeys on which passengers will come to

BARTD by a Muni route (Muni-BARTD), by an AC route (AC-BARTD) and in various other combinations (i.e., Muni-BARTD-Muni, AC-BARTD-AC, Muni-BARTD-AC, AC-BARTD-Muni, BARTD-Muni, and BARTD-AC).

BARTD Fare Plans B-1 to B-4 were tested in combination with AC Transit alternate Plans A-1 and A-2, as well as Muni Plans M-1 to M-3 —making a total of 24 complete multi-system analyses.

In the light of anticipated riding levels, present cost levels, and prevailing transportation fares in the Bay Area and elsewhere, two combinations of fare plans were selected for final review in relation to projected 1975 patronage levels. Ultimate consideration was focused on these two combination fare plans designated herein as Machine Runs V and VI. These fare structures are described below in terms of the rates applicable on each of the three Bay Area transit systems; the fares for a journey involving more than one of the three systems are described separately, following discussion of the single-system fares.

FARES AND PASSENGER REVENUE UNDER MACHINE RUN V

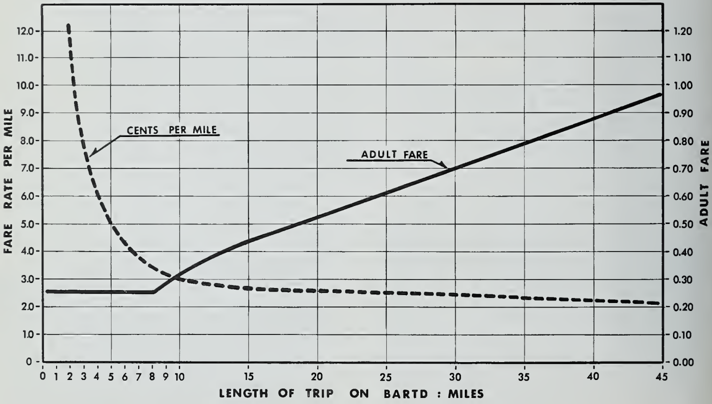
Machine Run V consisted of Fare Plans B-1, A-1 and M-2, representing a minimum level reasonably to be considered. With respect to BARTD, this represented the fare schedule set out in the Composite Report, the detailed point-to-point amounts of which are set forth in Table 51.

Figure 41 depicts the relationship of fares to length of journey on the BARTD system under Plan B-1. It reflects the rate of fare for trips of various lengths, together with the incremental rate per mile. This fare schedule was devised, of course, in the light of transportation fares and costs existing six years ago when the BARTD Composite Report was prepared.

FIGURE 41

BARTD ADULT FARE AND RATE PER MILE

FARE PLAN B-1



The AC Transit system fares under this plan have been applied at their current level (Plan A-1 among the AC Transit alternates). The basic adult fare is 25¢, with a reduced single-zone fare of five for $1.00. The fare for children or students[2] is 15¢.

The Muni fare in Machine Run V has been applied at 20¢ for a single-vehicle surface ride, and 25¢ for a single-vehicle Muni Rapid trip (Plan M-2 among the Muni alternates). A 5¢ transfer charge is included for any two-vehicle ride on the Muni system; i.e., 25¢ for two surface legs and 30¢ for a combination rapid-surface trip. The transfer charge has been applied only once on a one-way journey; transfers to third and subsequent vehicles would be free. Finally, a student and child's fare of 10¢ is included in this plan. The Machine Run V fare schedule for Muni compares with a present 15¢ universal fare for adults and a 5¢ fare for children and students.

In view of prevailing high cost levels on Muni, no fare structure within the current range of alternatives can be expected to eliminate operating deficits. However, it may be desirable, in the light of continuing cost pressure, to bring the Muni fare levels at least into the range of fares prevailing elsewhere. It was determined, therefore, that the minimum fare which should be considered for the Muni system in making riding and revenue projections is a 20¢ cash fare, plus a 5¢ transfer charge. This places the Muni fare schedule closer to fares prevailing on other major systems, although still in the lower portion of that range.

Combination Fares for Inter-system Journeys

Machine Run V incorporated a 10¢ surface feeder fare on either Muni or AC Transit for a passenger carried to or away from BARTD. Only one such feeder fare would be collected by one of the local surface carriers. If a passenger rode a Muni vehicle both before and after a BARTD trip, one 10¢ surface fare would be collected. The same principle was applied to a journey involving an AC Transit ride both before and after a BARTD trip.

TABLE 51

FARE PLAN B – 1
PROPOSED IN COMPOSITE REPORT
MAY 1962

Typical Stations

FARE PLAN FORMULA

25¢ First 8 Miles

Incremental Fares in 5¢ multiples far trips of more than 8 Miles.

$1.00 Maximum Fare

TRANSBAY – Added 10¢ Fare Increment

	Daly City	24th. Street	Downtown San Francisco	Downtown Oakland	MacArthur	Orinda	Walnut Creek	Concord	Berkeley	El Cerrito	Richmond	Fruitvale	San Leandro	Hayward
24th. Street	$0.25													
Downtown San Francisco	0.25	$0.25												
Downtown Oakland	0.55	0.40	$0.35											
MacArthur	0.55	0.45	0.40	$0.25										
Orinda	0.70	0.60	0.55	0.25	$0.25									
Walnut Creek	0.80	0.75	0.70	0.45	0.40	$0.25								
Concord	0.95	0.85	0.80	0.55	0.50	0.40	$0.25							
Berkeley	0.60	0.55	0.50	0.25	0.25	0.30	0.45	$0.55						
El Cerrito	0.70	0.60	0.55	0.25	0.25	0.40	0.50	0.60	$0.25					
Richmond	0.80	0.70	0.65	0.40	0.35	0.45	0.60	0.70	0.25	$0.25				
Fruitvale	0.60	0.50	0.45	0.25	0.25	0.35	0.50	0.60	0.25	0.35	$0.45			
San Leandro	0.70	0.60	0.55	0.25	0.35	0.45	0.60	0.70	0.40	0.45	0.55	$0.25		
Hayward	0.80	0.70	0.65	0.40	0.45	0.55	0.70	0.80	0.50	0.55	0.65	0.35	$0.25	
Fremont	1.00	0.90	0.85	0.60	0.65	0.75	0.90	1.00	0.70	0.75	0.85	0.50	0.45	$0.30

Under Machine Run V, a journey involving use of BARTD and either a Muni or an AC Transit surface line would require payment of a total fare of at least 45¢ in the absence of a combination rate. Under this combination fare, the joint ride would cost 35¢, a reduction of 10¢ or 22.2% from the sum of the regular fares required, if no discount were available.

A passenger using a Muni vehicle to reach BARTD and then another Muni vehicle after leaving BARTD would, under Machine Run V, pay 25¢ on BARTD, plus two 20¢ fares on Muni, or a total of 65¢ without a combination fare plan. The same would be true of a journey in the East Bay using AC Transit vehicles both before and after riding BARTD. Under the joint fare plan outlined above, such a trip would cost 35¢. Thus, the combination rate represents a saving of 30¢, or 46.2% of the aggregate of individual fares.

Calculating Passenger Revenue under Alternative Fare Plans

New rapid transit systems in Toronto, Montreal and Chicago opened in the past two decades have demonstrated that an overwhelming majority of the users of these systems are not new to transit. Studies on the Yonge Street Subway in Toronto show that 86% of the riders were previously surface transit users. The Congress Street rapid transit and the Skokie Swift demonstration in Chicago have measured the

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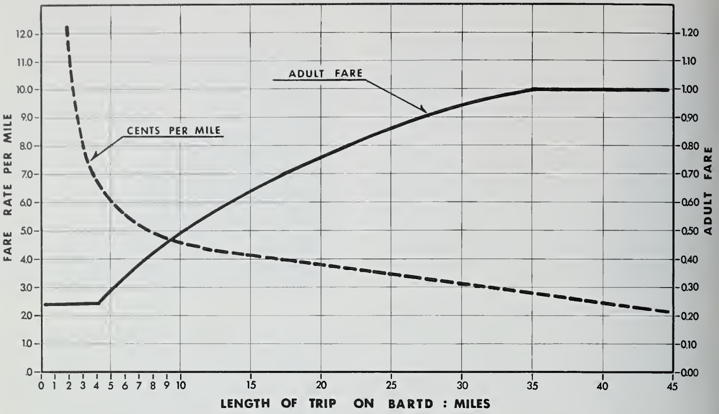
[2] In this, as well as all other references to students throughout this report, reduced fares apply only to grade and high school students.

FIGURE 42

BARTD ADULT FARE AND RATE PER MILE

FARE PLAN B-4



proportion of previous transit users at 85% on Congress Street and 75% on the Skokie Swift (Table 44). These facts do not lessen the importance of rapid transit in terms of its primary task of winning people over from auto travel but do point up the need for a careful analysis of sub-modal split—the distribution of transit users between rapid and surface lines.

Travel time diversion curves for distribution of transit riders between surface and rapid lines have been developed in large urban areas to reflect the relative convenience of surface transit for short trips and passenger reluctance to go down into a subway or up to an elevated structure.[3]

The gross transit market previously derived for 1975 was developed on the basis of factors which affect total transit use and assigned to specific transit lines on the basis of the route or combination of routes representing the minimum time path from origin to destination. Thus, for example, a short trip of a mile or mile and one-half was originally assigned to the rapid transit system as opposed to a surface alternative, whenever the trip time on the rapid transit line was slightly less than the surface route, regardless of fare differences.

However, an element of the "sub-modal split" problem is the fare differential between rapid transit and surface lines. With rapid transit fares higher than surface travel, a significant group of rapid transit patrons will prefer the slower surface alternative. Only when time savings on rapid transit are large (15 minutes or more) do most riders prefer that service to the alternative surface lines, despite a fare differential.

Based on experience in other rapid transit cities, a "family" of time differential diversion curves was developed by NCTDP (Figure 43), stratified by fare differences between rapid and surface transit. Thus, a trip which had a five-minute saving on rapid transit with 10¢ additional fare was analyzed differently than a trip with the same time saving but with a 20¢ fare differential.

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[3] Penn Jersey Technical Memorandum Series, *TM 14-9: Mass Transportation Diversion Curves, Subway-El vs. Surface Lines (RR Excluded)*, 1960.

The process outlined above was, in effect, a series of internal redistributions of traffic between rapid transit and surface routes. It did not affect the aggregate volume of riding on the Bay Area transit systems in 1975. This process represented essentially the shifting to surface lines of trips which, strictly on a time comparison basis, would all have been assigned to the rapid transit system.

Impact of Fare Increase Upon Passenger Volume

The next step was to determine the riding volumes under specific fare plans. Most of the fare plans analyzed in this study for the 1975 Bay Area transit systems involved increases in fare from existing systems in 1965. The minimum BARTD fare under various alternatives is 25¢, which compares with a present 15¢ basic fare in San Francisco and a 20¢ minimum fare on the AC Transit system. Machine Run V included a 20¢ basic fare on Muni surface lines as well. Each of these increases above present fare levels required a modification of transit riding projections developed previously for the 1975 three-system network.

The impact of price change on transit patronage has long been the subject of intensive study. For more than two decades, Simpson & Curtin has conducted continuing analyses of the effect of transit fare changes for transit systems and regulatory authorities throughout the United States. Universally, fare increases in the range here being considered for the Bay Area systems have produced revenue gains for the transit systems involved. It is not until the minimum or basic fare level reaches 30¢ or 35¢ that diminishing returns may offset the revenue yield. But it is also a universal phenomenon that some passenger riding is lost due to each fare increase, no matter how nominal that increase may be (Figure 44).

The factor used to define the rate of passenger loss attributed to a fare increase is known as the "loss ratio" or "shrinkage ratio." This is the factor which when multiplied by the percentage increase in fare determines the rate of passenger loss as a result of higher price. The loss ratio is determined for a particular fare change by first identifying the trend of riding on the system immediately prior to a fare change, generally for a period of several months. This trend is determined by comparing the level of patronage in the months immediately prior to the fare change with the same months one year earlier. This measurement eliminates seasonal variations, since comparisons are made between corresponding months in succeeding years.

A similar analysis is made for the months subsequent to the fare increase, i.e., riding for this period is compared with the same months one year earlier and the percentage change is calculated. The percentage change in riding in the period after the fare change is then compared with the normal trend immediately before the increase and the difference in percentage trend measures the impact of the fare increase on transit riding. This net loss in patronage is divided by the percentage increase in the average fare and the result is the loss ratio for the fare increase under analysis.

The loss ratios for fare increases in a group of representative cities are shown on Table 52. The last fare change in San Francisco, which occurred in June 1952, raised the adult rate from 10¢ to 15¢. Prior to the fare increase, traffic had been declining slowly at a rate of 1.87%; this drop was accelerated after the fare increase to a rate of 11.04%. The net traffic decline due to the 50% fare increase, therefore, was 9.17%, resulting in a loss ratio of 0.18.

In light of prior experience in San Francisco and other fare changes throughout the United States, it was estimated that a loss ratio of

FIGURE 43

EFFECT OF FARE AND TIME DIFFERENTIALS ON RAPID TRANSIT USE

SUB-MODAL SPLIT

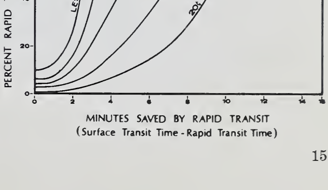
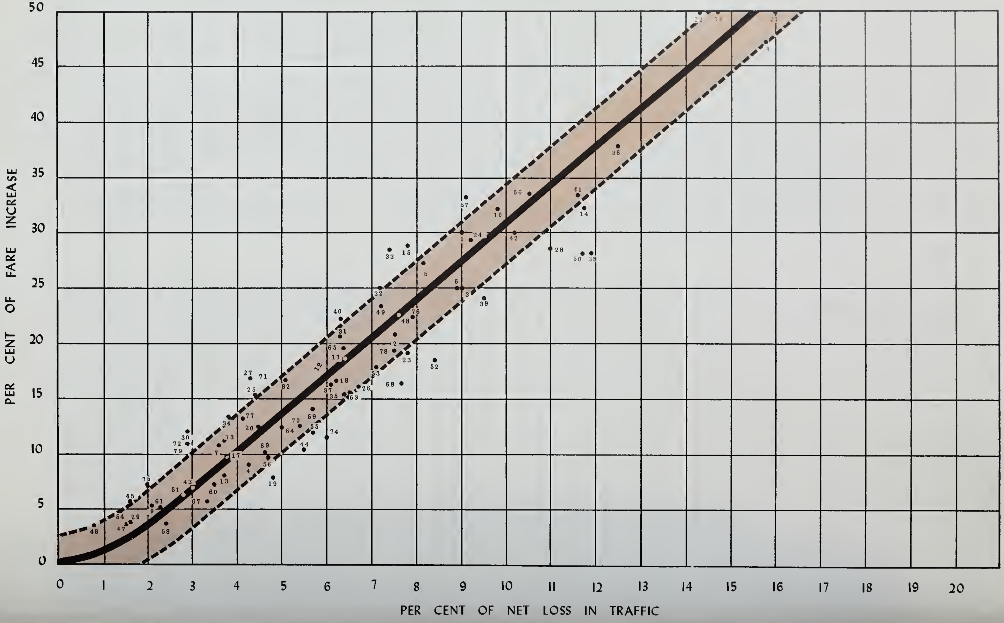


FIGURE 44

SHRINKAGE IN PASSENGER TRAFFIC DUE TO FARE INCREASE

TRANSIT PROPERTIES THROUGHOUT THE UNITED STATES



0.20 would be applicable in the Bay Area for fare increases establishing a minimum fare of 25¢ or less. Under Machine Run V, for example, the single-vehicle surface fare would be 20¢ as against the present 15¢ level in San Francisco, a fare increase of 33-1/3%. The loss ratio was applied at 0.20 to produce a reduction of 6.67% in Muni patronage under the 20¢ fare.

There was an additional element to be considered in predicting the impact of fare changes on the BARTD and Muni Rapid transit systems. A lower shrinkage loss was anticipated because of the superior quality of service and passenger amenities represented in rapid transit as compared to existing forms of transit in the Bay Area. Patrons will be required to pay more than they do now, but they will be getting a faster and more comfortable journey in more attractive vehicles. While an increase in fares for rapid transit journeys above existing surface fares can be expected to have some effect on riding, it will be less than the passenger loss which would result from a higher fare on existing routes and service. In calculating the impact of a rate increase from the existing surface transit fare to a proposed higher rapid transit fare, therefore, a loss ratio of 0.10 was applied.

Rapid transit journeys in many cases will involve access by surface transit vehicles to rapid transit lines and/or the use of surface lines for reaching the final destination after leaving rapid transit. These surface feeder legs were treated as a part of the rapid transit trip, and the loss ratio of 0.10 was applied to the entire journey. The 0.20 loss ratio was applied only to journeys completed entirely on surface routes.

Revenue Passengers and Passenger Revenue in 1975 under Machine Run V

Anticipated 1975 passenger volumes and resulting revenues were developed for each of the three Bay Area transit systems in relation to one another under Machine Run V, combining Fare Plans B-1 with A-1 and M-2.

BARTD Passenger and Revenue Projections Under Machine Run V

It was estimated previously that the BARTD system would have a potential volume of 253,353 passengers on the average weekday in 1975, before consideration of fare changes.

The time advantage which BARTD will enjoy over surface transit in transbay trips is so great that no fare-time diversion adjustment

Table 52

PASSENGER "LOSS RATIO" RESULTING FROM FARE INCREASES
Major Transit Systems Increasing Fares to Levels up to 25 Cents

Date	City	Cash Fare Increase		Loss Ratio
		From	To	
June 1952	San Francisco	10¢	15¢	0.18
July 1953	New York	10¢	15¢	0.20
July 1966	New York	15¢	20¢	0.18
Oct. 1955	Boston (Surface)	13¢	15¢	
	(Rapid Transit)	18¢-20¢	20¢	0.19
Feb. 1958	Portland	20¢	25¢	0.28
Dec. 1963	Salt Lake City	20¢	25¢	0.12
June 1958	Connecticut Co.	15¢	20¢	0.28
Oct. 1963	Atlanta	20¢	25¢	0.28
July 1957	Cincinnati	20¢	25¢	0.24
Jan. 1954	Philadelphia	15¢	18¢	0.14
Oct. 1958	Baltimore	20¢	25¢	0.08
Jan. 1954	NYC Omnibus	10¢	13¢	0.30
July 1957	Chicago	20¢	25¢	0.30

Table 53

DAILY BARTD REVENUE PASSENGERS IN 1975

Under Fare Plans B-1 and B-4

Type of Journey	Gross Daily Volume Based on Minimum Time Path	Daily Volume After Sub-Modal Split	
		Plan B-1	Plan B-4
Transbay	73,036	72,356	69,503
East Bay	60,158	46,689	47,336
San Francisco	120,159	79,132	77,577
TOTAL	253,353	198,177	194,416

was made for these journeys. From those areas on the East Bay where bus transportation can effectively compete with BARTD, transbay bus lines have been continued in the recommended transit network and trips assigned to those lines. The balance of transbay trips will involve substantial time savings on BARTD; therefore, the riding projections do not divert any of these BARTD riders to surface alternatives, regardless of fare difference, since they would require far greater time.

For trips within San Francisco and internally in the East Bay region, a portion of the BARTD potential was diverted to surface lines, particularly for very short trips. Nearly half (48%) of the trips diverted to surface routes were one-station rides. After having reduced the potential BARTD volume for fare-time diversion, the remaining BARTD traffic was adjusted for the increase from the fare levels on existing transit systems, to that provided for BARTD journeys under Fare Plan B-1. Application of a loss ratio of 0.10 for each 1% increase under the proposed BARTD fares together with the fare-time diversion reduced daily volume to 198,177 riders. Subdivision of this average daily volume among the three principal types of BARTD journeys—transbay, East Bay and San Francisco—is shown on Table 53; impact of these adjustments is heaviest on the local service in San Francisco, with only minor influence on transbay volumes.

Net effect of the double adjustment—the fare-time diversion to surface routes and shrinkage for higher fare—was a reduction to 57,647,315 revenue passengers in 1975.

The manner in which BARTD revenue passengers would be distributed among various fare classifications under Machine Run V is shown in Table 54. More than half (52.48%) of BARTD patrons would be carried at the 25¢ rate under this plan. Three-quarters would be at or below a 50¢ fare and over 90% would pay 70¢ or less. The average adult fare would be 36.7¢, while the average for all BARTD patrons would be 36.0¢ under Fare Plan B-1.

Annual revenue from adult riding on the BARTD system under this fare plan is projected at $20,159,373 in 1975. An allowance was made for school and student riders and revenue, totaling $604,781. Additionally, 1% of adult passenger revenue was added for advertising and concession revenues, in line with the prevailing relationship of advertising income on other transit systems.

Thus, the combined BARTD passengers under Machine Run V are projected at 57,647,315, while operating revenue would be $20,965,748. Distribution of projected annual adult BARTD passengers and revenue among transbay, East Bay and San Francisco lines is shown on Table 55, together with corresponding passenger and revenue projections for the Muni and AC Transit systems.

Muni Revenue and Passenger Projections Under Machine Run V

Machine Run V involved a 20¢ fare on the Muni surface system with a 5¢ transfer charge, and a 25¢ fare on Muni Rapid (Fare Plan M-2). It also included a 5¢ transfer charge if Muni surface vehicles were used to or from a Muni Rapid line.

The projections of passengers and revenue on Muni Rapid routes are shown on Table 56. These passenger volumes for Muni Rapid reflect not only the impact of diversion between rapid transit and surface lines, but also the passenger loss flowing from an increase in fares to 25¢ on the rapid transit lines (30¢ for a rapid-surface journey) from the present 15¢ fare on the Muni system.

Under Fare Plan M-2, it is estimated that the three Muni Rapid lines—Richmond, Sunset and Twin Peaks—will carry a total of 40,769,753 adult passengers. Richmond Rapid would be the largest single line with 15.7 million riders, followed by Sunset Rapid with 14.3 million and Twin Peaks with 10.7 million passengers. Revenue from adult rapid transit passengers will aggregate $10,192,439 in 1975, not including the 5¢ charge for feeder connections.

In order to complete the passenger and revenue projections for Muni Rapid, an allowance was made for child and student riders and for advertising revenue. As for BARTD, child and student passengers on Muni Rapid were projected at 5% of adult volume, then extended at the 10¢ rate under Plan M-2.

After allowance for these and addition of advertising revenue, the plan produced $10,498,212 revenue from 42,808,241 passengers on Muni Rapid.

Muni Surface Line Projections. Under Fare Plan M-2, the Muni surface system, with a 20¢ basic fare and a 5¢ transfer charge, was projected to yield $19,390,751 in revenue from 151,920,925 adult passengers annually.

This plan represents a 5¢ increase in basic fare for Muni surface passengers. In the derivation of passenger volumes, a loss ratio of 0.20 was applied in each instance. Additional passengers and revenue were incorporated in the projection to reflect school and child riding. In addition, an allowance was added for advertising revenue. These added 17,161,500 passengers and $1,927,219 in revenue to the adult totals above.

Therefore, for the surface system, Fare Plan M-2 produced revenue of $21,317,970 from a total of 169,082,425 passengers.

Summarizing, the Muni system—Muni Rapid and the surface lines together—is expected to produce revenue of approximately $31.8 million and carry 212 million passengers annually under the 20¢ fare Plan (M-2).

Table 54

BARTD 1975 REVENUE PASSENGERS AND PASSENGER REVENUE
By Fare Classification Under Machine Run V

	Passengers			Revenue		
Rate of Fare	Number	Percent	Cumulative Percent	Amount	Percent	Cumulative Percent
25¢	30,248,667	52.48%	52.48%	$ 7,562,167	36.07%	36.07%
30¢	634,410	1.10	53.58	190,323	0.90	36.97
35¢	4,776,885	8.29	61.87	1,671,910	7.97	44.94
40¢	2,189,940	3.80	65.67	875,976	4.18	49.12
45¢	4,006,815	6.95	72.62	1,803,067	8.60	57.72
50¢	3,302,763	5.73	78.35	1,651,382	7.87	65.59
55¢	2,804,970	4.87	83.22	1,542,734	7.36	72.95
60¢	1,508,505	2.62	85.64	905,103	4.32	77.27
65¢	1,524,465	2.65	88.49	990,902	4.73	82.00
70¢	1,678,080	2.91	91.40	1,174,656	5.61	87.61
75¢	643,815	1.11	92.51	482,861	2.31	89.92
80¢	756,960	1.31	93.82	605,568	2.88	92.80
85¢	817,665	1.42	95.24	695,015	3.31	96.11
90¢	3,990	(a)	95.24	3,591	0.02	96.13
95¢	3,135	(a)	95.24	2,978	0.01	96.14
$1.00	1,140	(a)	95.24	1,140	0.01	96.15
Adults	54,902,205	95.24%	95.24%	$20,159,373	96.15%	96.15%
Children & Students	2,745,110	4.76	100.00	604,781	2.88	99.03
Subtotal	57,647,315	-	-	$20,764,154	-	-
Advertising	-	-	-	201,594	-	-
TOTAL	57,647,315	100.00%	100.00%	$20,965,748	100.00%	100.00%

(a) Less than 0.01% in each of these categories.

Table 55

BAY AREA TRANSIT SYSTEMS
1975 Annual Adult Passengers and Revenue
Under Machine Run V

System (Fare Plan)	Passengers	Revenue
BARTD (B-1)		
Transbay	20,217,045	$10,734,468
East Bay	12,459,060	3,868,305
San Francisco	22,226,100	5,556,600
BARTD Total	54,902,205	$20,159,373
Muni (M-2)		
Richmond Rapid	15,730,533	$ 3,932,633
Sunset Rapid	14,292,251	3,573,063
Twin Peaks Rapid	10,746,969	2,686,743
Muni Rapid Total	40,769,753	$10,192,439
Surface Only	61,902,919	$13,333,889
Surface - BARTD	44,252,806	4,008,702
Surface - Muni Rapid	45,765,200	2,048,160
Muni Surface Total	151,920,925	$19,390,751
Muni System Total	192,690,678	$29,583,190
AC Transit (A - 1)		
Surface Only	19,371,574	$ 4,630,981
Surface - BARTD	24,682,875	2,358,100
AC System Total	44,054,449	$ 6,989,081
TOTAL	291,647,332	$56,731,644

AC Transit Revenue and Passenger Projections Under Machine Run V

AC Transit was projected to carry 44,054,449 adult passengers in 1975 under Fare Plan A-1. Of this total, 24,682,875 would be BARTD passengers carried to or from stations; the remainder would be AC Transit riders without use of BARTD. AC Transit adult passenger revenue under this plan was estimated at $6,989,081.

The average fare for adult riders on AC Transit under Fare Plan A-1 would be 15.86¢. This average is well below the basic or minimum adult fare by reason of the fact that over 56% of passengers would be taking surface-feeder trips to or from BARTD at half the minimum adult fare.

Derivation of passenger estimates for AC Transit employed the techniques described previously. This involved adjustments in the gross market for the East Bay transit systems to shift passengers among alternate routes (i.e., BARTD and AC Transit) on the basis of passenger convenience, time and fare differentials.

After determining the adult passenger and revenue projections for the AC Transit system, consideration was given to the future volume of child and student riders and an additional increment for advertising revenues. It was estimated that the number of 15¢ passengers on the AC Transit system in 1975 will be 17,179,500. At the 15¢ child and student rate under Fare Plan A-1, the revenue from these passengers will aggregate $2,576,925.

Based on the normal experience in the industry as well as on AC Transit in recent years, advertising revenue was added at 1% of aggregate passenger revenue.

With these elements added to the adult figures developed above, Fare Plan A-1 is expected to produce annual revenue of $9,661,666. Passengers will total 61,233,949 for the year 1975.

Summary of Revenue and Passengers For Bay Area Transit Systems in 1975 Under Machine Run V

Passenger and revenue volumes from Machine Run V for each of the three Bay Area transit systems are summarized in Tables 55 and 57. The first of these deals solely with adult riding and revenues under this machine run, while Table 57 includes child and student riding and advertising income as well as adult patronage. Table 57, therefore, reflects total patronage and passenger-plus-advertising revenue.

Under Machine Run V, BARTD is projected to carry 57.6 million passengers and realize revenue of $20,966,000.

The Muni system passengers are estimated at 211.9 million and revenues at $31,816,000.

AC Transit passengers are projected at 61.2 million, with revenues totaling $9,662,000.

The three systems, therefore, are expected to accommodate 331 million revenue passengers in 1975 with operating revenue of $62.4 million under the foregoing low-level fare proposals.

As shown in succeeding Chapter 13, these projected revenue yields were deemed insufficient to support the desired levels of service on each of the three systems. BARTD Fare Plan B-1 was developed originally on the basis of 1960 cost levels, as was AC Transit Fare Plan A-1. A substantial rise in general price levels and particularly in transit costs has taken place since then.

Higher costs and modified patronage estimates from prior analyses of BARTD prospects required a re-examination of the fare structure originally proposed for BARTD. On the assumption that the service levels which were originally designed to provide the most attractive service possible will be retained insofar as practicable, the main avenue available to restore the relationship of revenues to costs contemplated in the 1962 Composite Report was to raise fares. Accordingly, a series of higher fare structures—Plans B-2, B-3 and B-4—was studied. That re-examination rested upon retention of a minimum 25¢ fare and a maximum $1.00 fare, the limits originally established in the Composite Report fare structure.

The nature of the BARTD system and its function in the communities served, as well as relatively wide station spacing, are among the factors which reinforced the original decision in the Composite Report to retain the minimum

Table 56

1975 REVENUE PASSENGERS AND PASSENGER REVENUE
On Muni Rapid Transit Lines Under Fare Plan M-2

Muni Rapid Line	Passengers	Revenue
Richmond	15,730,533	$ 3,932,633
Sunset	14,292,251	3,573,063
Twin Peaks	10,746,969	2,686,743
Subtotal - Adults	40,769,753	$10,192,439
Children and Students	2,038,488	203,849
Subtotal	42,808,241	$10,396,288
Advertising		101,924
TOTAL	42,808,241	$10,498,212

Table 57

BAY AREA TRANSIT SYSTEMS
1975 Annual Adult, Child and Student Passengers,
Passenger and Advertising Revenues
Under Machine Run V

System (Fare Plan)	Adult, Child and Student Passengers	Passenger and Advertising Revenue
BARTD (B-1)	57,647,315	$20,965,748
Muni Rapid (M-2)	42,808,241	10,498,212
Muni Surface (M-2)	169,082,425	21,317,970
Muni System Total	211,890,666	$31,816,182(a)
AC Transit (A-1)	61,233,949	9,661,666(b)
TOTAL	330,771,930	$62,443,596

(a) It is estimated that special and charter revenues will add $300,000 annually to the line passenger and advertising revenues shown here.

(b) It is estimated that charter revenues will add $800,000 annually to the line passenger and advertising revenues shown here.

at no less than 25¢. By the same token, prevailing local transit fares in the Bay Area—particularly the traditional low-fare policy which has applied in San Francisco—dictated that the basic fare under present-day circumstances should not be projected at more than 25¢.

At the other end of the fare analysis, it was felt that a one-way fare of more than $1.00 might effectively discourage regular riding for the longest hauls on the system (although these are expected to be few in any event), and that a policy ceiling of $1.00 for a cash fare ought to be retained.

The new fare plans, therefore, were designed to lower the maximum length of trip available for the 25¢ basic fare and modify the step rates in the fare formula to the extent necessary to produce the required revenues.

MACHINE RUN VI—FARE PLANS B-4, A-2 AND M-3

Machine Run VI was designed to test the productivity of the maximum fares feasible under present acceptance levels. It involved a 25¢ universal fare with free transfers among surface lines on the Muni system (Plan M-3 shown on Page 147). Similarly, the minimum fare for a one-zone rider on the AC Transit system would be 25¢ with free transfer privileges (Plan A-2 on Page 147).

The fare on Muni Rapid would also be 25¢ with a 5¢ transfer charge between Muni surface and Muni Rapid lines. The maximum journey fare on the Muni system would be 25¢ for a trip entirely on the surface, and 30¢ for any combination of surface and rapid transit vehicles.

The fare for children and students on both the Muni and AC Transit systems was set at 15¢ under Fare Plans M-3 and A-2.

A 25¢ adult fare is now dominant among the large transit systems of the country. While there are some systems with a minimum fare above or below a quarter, the 25¢ rate has become standard in most large communities and now represents the generally accepted level.

A number of major transit properties have a 25¢ minimum (cash or token) adult fare, together with a transfer charge. These include Chicago, Cleveland, St. Louis and Pittsburgh among the publicly owned systems, and Philadelphia, Baltimore, Buffalo, Cincinnati, and

Kansas City among the large privately owned companies. Several of the aforementioned systems have a transfer charge in addition to a minimum adult fare above 25¢. Thus, a plan involving a 25¢ basic fare with free transfer privileges is well within the prevailing level of transit fares in major metropolitan areas today.

BARTD Fare Plan B-4. The BARTD fare under Machine Run VI was based on the formula identified as Plan B-4 on Page 147. It is keyed to a 25¢ basic fare for a four-mile BARTD trip.

The point-to-point tariff for typical stations on the BARTD system under Fare Plan B-4 appears in Table 58. The fares shown in this schedule represent application of the mileage formula as shown. Where that formula would result in a fare above \$1.00, a \$1.00 maximum was applied in making riding and revenue projections.

Figure 42 depicts the relationship of adult fare to length of journey for trips of various length on the BARTD system under Fare Plan B-4. In addition, the chart shows the declining rate per mile resulting from block rates in the formula.

The difference in average fare between the Composite Report fare schedule (Fare Plan B-1) and the final plan tested for BARTD (Fare Plan B-4) is approximately 9¢, or 25%. More than 70% of the revenue gain between these two fare proposals would be derived from higher transbay fares. These are the trips on which BARTD has the greatest competitive advantage in terms of both time and cost. The formula for Fare Plan B-4 was devised to maximize the revenue yield from transbay trips, producing an average fare of slightly over 71¢ as contrasted with 52.5¢ for the same journeys under Fare Plan B-1.

There is little difference between these two fare plans in terms of average fare on the peninsula. Both plans involve a 25¢ fare for trips within the city of San Francisco. The only difference is that trips from Daly City to downtown San Francisco are 30¢ or 35¢ under Plan B-4 as compared with a 25¢ level under Plan B-1. On the East Bay, the average adult fare has been increased from 30.7¢ under Plan B-1 to 39.5¢ under Plan B-4. This results from the general increase in fare levels, retaining a 25¢ minimum for a four-mile trip and increasing the fares in accordance with the Plan B-4 formula for journeys longer than four miles.

Combination Fares

Machine Run VI included a minimum 25¢ adult fare on both Muni and AC Transit. Under this combination plan, the surface feeder rate was established at one-half of the basic adult fare, i.e., 12½¢ per one-way feeder leg. The patron on either AC Transit or Muni using a surface vehicle to or from BARTD would be entitled to a round-trip surface feeder ride for the one-way surface fare.

The surface feeder fare would permit a passenger to use Muni lines both before and after the BARTD leg, for the same price that he would pay for the use of a single surface vehicle in that one-way trip. This would also be true, of course, on the AC Transit system.

A journey involving use of one Muni or one AC Transit surface line, together with BARTD, would cost 50¢ under these fare plans, without a joint fare arrangement. This is the sum of the 25¢ minimum fare on BARTD (B-4) plus the basic quarter fare on either surface system (M-3 or A-2). The combination fare proposed under Machine Run VI would establish a rate of 37.5¢ for the two-vehicle ride, affording a saving of 12.5¢, or 25%.

TABLE 58
FARE PLAN B-4
PROSPECTIVE BARTD FARES
Typical Stations

FARE PLAN FORMULA

25¢ First 4 Miles
25¢ +4¢/mile - 4 to 10 Miles
50¢ +3¢/mile - 10 to 15 Miles
65¢ +2¢/mile - over 15 Miles
\$1.00 Maximum Fare

TRANSBAY - Mileage plus 4 Miles with 50¢ Minimum

PENINSULA - 25¢ Fare within San Francisco
35¢ Maximum Fare

	Daly City	24th Street	Downtown San Francisco	Downtown Oakland	MacArthur	Orinda	Walnut Creek	Concord	Berkeley	El Cerrito	Richmond	Fruitvale	San Leandro	Hayward
24th Street	\$0.25													
Downtown San Francisco	0.35	\$0.25												
Downtown Oakland	0.75	0.60	\$0.55											
MacArthur	0.75	0.70	0.60	\$0.25										
Orinda	0.90	0.80	0.75	0.40	\$0.35									
Walnut Creek	1.00	0.90	0.85	0.65	0.60	\$0.25								
Concord	1.00	1.00	1.00	0.75	0.75	0.55	\$0.35							
Berkeley	0.85	0.75	0.70	0.30	0.25	0.55	0.75	\$0.85						
El Cerrito	0.90	0.80	0.75	0.40	0.30	0.65	0.80	0.95	\$0.25					
Richmond	0.95	0.90	0.85	0.55	0.50	0.75	0.90	1.00	0.35	\$0.25				
Fruitvale	0.80	0.70	0.60	0.25	0.30	0.60	0.75	0.85	0.40	0.55	\$0.65			
San Leandro	0.90	0.80	0.75	0.40	0.50	0.65	0.85	0.95	0.60	0.70	0.75	\$0.30		
Hayward	1.00	0.90	0.85	0.60	0.65	0.80	0.95	1.00	0.75	0.80	0.85	0.50	\$0.30	
Fremont	1.00	1.00	1.00	0.85	0.85	1.00	1.00	1.00	0.95	1.00	1.00	0.75	0.65	\$0.50

Table 59

COMPARATIVE FARES AND RATES PER MILE
Cash Fares for Trips of 10 Miles or More
Peninsula Lines of Southern Pacific Railroad and Greyhound and BARTD Fare Plan B-4

	Southern Pacific Railroad San Francisco - San Jose Line				Greyhound San Francisco - San Jose Line		BARTD Fare Plan B-4	
	Present Fares		Proposed Fares					
Miles	Cash Fare	Rate per Mile	Cash Fare	Rate per Mile	Cash Fare	Rate per Mile	Fare	Rate per Mile
10	$ .60	6.00¢	$ .95	9.50¢	$ .45	4.50¢	$ .50	5.00¢
15	.73	4.87	1.15	7.67	.55	3.67	.65	4.33
20	.91	4.55	1.35	6.75	.75	3.75	.75	3.75
25	.91	3.64	1.35	5.40	.90	3.60	.85	3.40
30	1.14	3.80	1.60	5.33	1.00	3.33	.95	3.17
35	1.32	3.77	1.80	5.14	1.10	3.14	1.00	2.86
40	1.32	3.30	1.80	4.50	1.30	3.25	1.00	2.50
45	1.45	3.22	1.95	4.33	1.45	3.22	1.00	2.22

A three-vehicle journey in which the BARTD trip is taken between two AC Transit surface legs, or between two Muni surface legs, would cost 75¢ with no joint fare arrangement. With the joint fare proposed, the three-vehicle trip would cost 37.5¢, representing a 50% reduction.

Neither combination in Machine Runs V or VI contemplated any tie-in in joint fare arrangement between Muni and AC Transit. Thus, a passenger using an AC Transit bus to reach BARTD, traveling on BARTD to San Francisco and transferring to a Muni surface route would have separate feeder fare transactions on each side of the Bay. A three-system trip under Machine Run VI, assuming 50¢ for the BARTD ride, would cost 75¢ under the joint fare plan, as opposed to $1.00 in the absence of a combination rate, a saving of 25¢.

Comparison of Proposed BARTD Fares with Other Transportation Fares in the Bay Area

The basic mileage formula under BARTD Fare Plan B-4 produces a 50¢ fare for a 10-mile trip, graduated with distance to a maximum of $1.00. At 10 miles, the rate per mile is 5¢. As the trip lengthens, this mileage rate decreases until, for the longest trips, the rate per mile is under 2.5¢.[4]

A comparison was made between Fare Plan B-4 and the cash fares for trips of 10 miles or more on the Southern Pacific Railroad and Greyhound Lines in the Bay Area. Trips of 10 to 45 miles, in five-mile increments, were used for this comparison which appears in Table 59. This table lists the present cash fares for Southern Pacific and Greyhound, as well as higher fare rates requested by the Southern Pacific. The comparison shows that proposed BARTD fares under this schedule are in line with the basic fare schedules of both Southern Pacific and Greyhound; the BARTD fares for journeys of 10 to 20 miles generally fall between the railroad fares at a higher level and Greyhound at a lesser rate. For journeys of 25 miles or longer, the BARTD fares are generally less than Greyhound fares and substantially below the Southern Pacific cash rates.

The Greyhound and Southern Pacific tariffs include not only cash fares but various forms of discount tickets for regular users. Table 60 compares the proposed BARTD fares under Plans B-1 and B-4 with Greyhound cash and monthly commuter unit fares for trips between San Francisco and various points in Contra Costa County, as well as between Oakland and Concord. The BARTD fares under Plan B-4 are 5¢ to 15¢ below Greyhound cash fares for trips between San Francisco and points on the BARTD line between Lafayette and Concord. The BARTD fare is also 5¢ less than the Greyhound cash fare between Oakland and Concord. However, when the Greyhound monthly commuter unit fare is calculated on the basis of full utilization, the fare per ride is considerably less under the Greyhound tariff.

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[4] It should be noted that this description applies to the basic mileage formula. For transbay trips, there is a deviation from the mileage formula, as described previously.

As indicated on Table 60, the fares shown for BARTD are those which have been used in passenger and revenue projections. In view of the established practice in the Bay Area to afford reduced rates to frequent riders, it would appear desirable to provide some reduction below the basic BARTD fare schedule for regular users. If some type of discount fare is to be applied on longer BARTD trips, the revenue loss resulting from that fare reduction would have to be offset by a compensating increase in fares for casual riders in order to achieve the level of revenue projected in this analysis for Fare Plans B-1 to B-4 for the BARTD system. This recommendation is developed further under the heading, "promotional fares."

Mileage fare rates under Plan B-4 for BARTD trips of various lengths were compared with present and proposed rates per mile for commutation tickets on the Southern Pacific Railroad line between San Francisco and San Jose. This comparison appears in Table 61. The BARTD rates per mile under this schedule are fractionally higher than the proposed railroad rates, assuming full utilization of the five-day monthly commutation ticket on the Southern Pacific Railroad. However, it should be borne in mind that the BARTD fares in this table are averages and are assumed to include, or to represent, the net effect of both cash and commutation rates. Thus, the commutation rate per mile on the BARTD system would be lower than the cash-commutation averages reflected in Table 61.

The fare rates per mile shown in Table 61 for BARTD are in line with fares charged for commutation tickets in the major rail commuter

Table 60

COMPARATIVE FARES
GREYHOUND AND BARTD FARE PLANS B-1 AND B-4
Between San Francisco and Contra Costa County
and Between Oakland and Concord

	Greyhound Cash Fare	Greyhound Monthly Commute Unit Fare	Proposed BARTD Fare (a)	
			Plan B-1	Plan B-4
Between San Francisco and:				
Orinda	75.0¢	42.3¢	55.0¢	75.0¢
Lafayette	85.0¢	49.8¢	65.0¢	80.0¢
Walnut Creek	95.0¢	54.5¢	70.0¢	85.0¢
Pleasant Hill	105.0¢	59.4¢	70.0¢	90.0¢
Concord	115.0¢	64.0¢	80.0¢	100.0¢
Between Oakland and:				
Orinda	40.0¢	24.7¢	25.0¢	40.0¢
Lafayette	50.0¢	26.2¢	40.0¢	55.0¢
Walnut Creek	60.0¢	30.9¢	45.0¢	65.0¢
Pleasant Hill	70.0¢	35.7¢	45.0¢	70.0¢
Concord	80.0¢	40.2¢	55.0¢	75.0¢

(a) The fares shown for BARTD are those which have been used in the passenger and revenue projections. These fares are assumed to be the average, including the effect of discount fares for regular riders.

cities of New York, Chicago and Philadelphia. Bearing in mind that the BARTD rates per mile on this table are averages, including the effect of lower commuter rates as well as slightly higher cash rates, the rate per mile for regular users would be something less than 5¢ for a 10-mile trip, approximately 4¢ per mile for a 15-mile journey, then tapering down to a rate of 2¢ to 2½¢ per mile for the longest journeys. These rates are in keeping with the level of commuter fares now in effect among major metropolitan centers.

Passengers and Revenue in 1975 Under Machine Run VI

Projections for traffic and revenue were made for each of the three systems in 1975, using the same fare-time diversion and shrinkage adjustments described earlier under Machine Run V.

BARTD Revenue and Passenger Projections Under Machine Run VI

Under Fare Plan B-4, the average adult fare on BARTD is 45.9¢. This is slightly more than 9¢, or 25%, above the average adult fare in Plan B-1.

Table 61

COMPARATIVE FARE RATE PER MILE

Present and Proposed Commutation Fares

on Southern Pacific Railroad and BARTD Fare Plan B-4

	So. Pacific RR Commute Rate (a)		
Mile	Present	Proposed	Fare Plan B-4 (b)
10	3.26¢	5.35¢	5.00¢
15	2.63¢	4.11¢	4.33¢
20	2.33¢	3.49¢	3.75¢
25	1.86¢	2.79¢	3.40¢
30	1.78¢	2.60¢	3.17¢
35	1.73¢	2.46¢	2.86¢
40	1.51¢	2.15¢	2.50¢
45	1.45¢	2.04¢	2.22¢

(a) Based on use of five-day monthly commutation ticket and an assumed 43 rides per month.

(b) The fare rates per mile listed for BARTD are those used in the passenger and revenue projections. These rates are averages, including effect of discount fares for regular riders.

Similarly, under Fare Plan B-4, the average weekday volume on BARTD was projected at 194,416, after allowance for fare-time diversion to surface routes and shrinkage for higher fares (Table 53). Although the average BARTD fare is 25% higher under Fare Plan B-4, the amount of diversion is only slightly greater than under B-1, by reason of the fact that the fare increase to 25¢ on both AC Transit and Muni works to the advantage of BARTD in retaining a higher proportion of potential traffic under the fare-time adjustment. This retention is dissipated by application of the shrinkage formula to the fare levels contemplated under Plan B-4, but the net effect is a difference of only 1.9% in traffic volume.

Adult passengers on BARTD under Fare Plan B-4 would total 53,859,840 in 1975 and provide $24,734,070 in fare revenues. Similar allowances to those described previously for children and students would add 2,692,922 riders and $742,022, respectively. The allowance for advertising and concessions is further estimated at $247,341. Summarizing these projected results of Fare Plan B-4 in 1975, as shown on Table 62, the BARTD system would carry 56,552,832 revenue passengers and aggregate $25,723,433 in passenger revenue.

It is particularly noteworthy that while traffic volume is 1.9% lower under Fare Plan B-4, its aggregate passenger revenue is 22.7% higher—more than $4¾ million—than under the fare proposal set out in the Composite Report, described herein as Fare Plan B-1.

Table 62 shows the distribution of adult passengers among fare categories under Fare Plan B-4. Nearly 42% would travel for 25¢, 56% for 50¢ or less, and 90% at or below 85¢. Fares in excess of 75¢ would apply to only 12.1% of total traffic volume.

The division of adult revenue passengers and passenger revenue among sections of the system in 1975 are shown, together with similar data for Muni and AC Transit operations, on Table 63.

Muni Rapid Revenue and Passenger Projections Under Machine Run VI

Under Fare Plan M-3, the Muni Rapid fare would be at 25¢ and there would be a 5¢ transfer charge for a ride involving both Muni Rapid and a Muni surface line. However, by reason of the increase in the surface fare on the Muni

Table 62

BARTD 1975 ADULT PASSENGERS AND REVENUE DISTRIBUTION BY FARE CLASSIFICATION
Fare Plan B-4

	Passengers			Revenue		
Rate of Fare	Number	Percent	Cumulative Percent	Amount	Percent	Cumulative Percent
25¢	23,619,486	41.76%	41.76%	$ 5,904,872	22.95%	22.95%
30¢	2,515,972	4.45	46.21	754,792	2.93	25.88
35¢	2,934,657	5.19	51.40	1,027,130	3.99	29.87
40¢	1,206,468	2.13	53.53	482,587	1.87	31.74
45¢	346,033	0.61	54.14	155,715	0.61	32.35
50¢	1,214,765	2.15	56.29	607,383	2.37	34.72
55¢	3,782,808	6.69	62.98	2,080,544	8.09	42.81
60¢	3,994,156	7.07	70.05	2,396,494	9.32	52.13
65¢	1,759,241	3.11	73.16	1,143,507	4.44	56.57
70¢	2,919,134	5.16	76.32	2,043,394	7.94	64.51
75¢	2,733,162	4.83	83.15	2,049,872	7.97	72.48
80¢	1,751,729	3.10	86.25	1,401,383	5.45	77.93
85¢	1,980,637	3.50	89.75	1,683,541	6.55	84.48
90¢	919,031	1.63	91.38	827,128	3.22	87.70
95¢	136,658	0.24	91.62	129,825	0.50	88.20
$1.00	2,045,903	3.62	95.24	2,045,903	7.95	96.15
Adults	53,859,840	95.24%	95.24%	$24,734,070	96.15%	96.15%
Children and Students	2,692,992	4.76	100.00	742,022	2.88	99.03
Subtotal	56,552,832	-	-	$25,476,092	-	-
Advertising	-	-	-	247,341	-	-
TOTAL	56,552,832	100.00%	100.00%	$25,723,433	100.00%	100.00%

system from 20¢ to 25¢ between Plans M-2 and M-3, the total riding on Muni Rapid is expected to be greater under Fare Plan M-3. The aggregate adult riding was projected at 42,509,331 passengers and the revenue at $10,627,335 (Table 64). The difference of $435,000 in Muni Rapid adult revenues between Plans M-2 and M-3 is the result of diversion of rides from surface alternates to the rapid transit system by reason of a 25¢ basic fare on both surface and rapid transit.

In order to complete the passenger and revenue projections for Muni Rapid, an allowance was made for child and student riders and for advertising revenue. After including these items, Fare Plan M-3 aggregates $11,052,428 in revenue from 44,634,798 passengers (Table 64).

Muni Surface Revenue and Passenger Projections Under Machine Run VI

The 25¢ basic fare on surface lines under Plan M-3 is expected to yield annual adult surface line revenue of $21,451,860. The surface adult passengers are projected at 146,787,514 (Table 63). In the derivation of passenger volumes for the Muni surface lines, a loss ratio of 0.20 was applied in each instance.

The assignment of adult passengers to Muni surface routes under Fare Plan M-3 as detailed in Technical Memorandum No. 53[5] revealed that the majority of riders—approximately 89 million out of 147 million annually—will be using these surface lines as an adjunct to a rapid transit trip either on BARTD or on one of the three Muni Rapid lines. As a consequence, the average adult fare on the surface lines under Fare Plan M-3 is only 14.6¢, although the basic fare is 25¢. This results from the fact that the proposed fare on surface feeders to Muni Rapid is 5¢ for one or more surface routes. Under Fare Plan M-3, the surface-feeder fare for a passenger going to BARTD is 25¢ for the round trip on the surface, or a unit rate of 12.5¢ for each one-way surface leg.

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[5] Simpson & Curtin, *Technical Memorandum No. 53: Fare Plans, Passenger and Revenue Projections,* November, 1966.

The passenger and revenue projections for Muni surface lines above are concerned only with adult patronage. Additional passengers and revenue were incorporated to reflect school and child riding. Further, an allowance was added for advertising revenue. The total surface lines' student and child passengers in 1975 under Fare Plan M-3 was projected at 17,074,533 and the revenue from these children, at a 15¢ fare, calculated at $2,561,180. Advertising revenue again was estimated at 1% of passenger revenue.

The total passenger and revenue yield under Fare Plan M-3 appears in Table 65. For the surface system, revenue is $24,253,232 while passengers aggregate 163,862,047.

For the entire Muni system—Muni Rapid and the surface lines together—Plan M-3 is expected to produce $35.3 million, with passengers aggregating 208.5 million annually.

AC Transit Revenue and Passenger Projections Under Machine Run VI

Like the other two systems, AC Transit minimum fare would be increased to 25¢ under

Table 63

BAY AREA TRANSIT SYSTEMS
1975 Annual Adult Passengers and Revenue
Under Machine Run VI

System (Fare Plan)	Passengers	Revenue
BARTD (B-4)		
Transbay	19,419,900	$14,014,305
East Bay	12,643,740	5,041,365
San Francisco	21,796,200	5,678,400
BARTD Total	53,859,840	$24,734,070
Muni (M-3)		
Richmond Rapid	17,245,559	$ 4,311,390
Sunset Rapid	14,377,088	3,594,273
Twin Peaks Rapid	10,886,684	2,721,672
Muni Rapid Total	42,509,331	$10,627,335
Surface only	57,848,190	$14,357,921
Surface - BARTD	43,234,124	5,045,329
Surface - Muni Rapid	45,705,200	2,048,610
Muni Surface Total	146,787,514	$21,451,860
Muni System Total	189,296,845	$32,079,195
AC Transit (A-2)		
Surface only	18,614,044	$ 4,952,517
Surface - BARTD	24,621,170	2,973,321
AC System Total	43,235,214	$ 7,925,838
TOTAL	286,391,899	$64,739,103

Table 64

1975 REVENUE PASSENGERS AND PASSENGER REVENUE ON MUNI RAPID TRANSIT LINES UNDER FARE PLAN M-3

Muni Rapid Line	Passengers	Revenue
Richmond	17,245,559	$ 4,311,390
Sunset	14,377,088	3,594,273
Twin Peaks	10,886,684	2,721,672
Subtotal - Adults	42,509,331	$10,627,335
Children and Students	2,125,467	318,820
Subtotal	44,634,798	$10,946,155
Advertising	-	106,273
TOTAL	44,634,798	$11,052,428

Machine Run VI. It is estimated that AC Transit adult passenger volume will be 43,235,214, while annual revenue will increase over Plan A-1 by nearly a million dollars to $7,925,838 (Table 63).

Derivation of passenger and revenue estimates for AC Transit was based on the same techniques as those described previously. This involved two adjustments, (1) a shift of passengers among alternate routes of BARTD and AC Transit on the basis of passenger convenience, time and fare differentials, followed by (2) shrinkage of passenger volumes on AC Transit as result of the increase in fare from 20¢ to 25¢. The loss ratio applied to AC Transit riding under Fare Plan A-2 was 0.20, the same factor used in projecting the impact of fare changes on Muni surface lines.

After determining the adult passenger and revenue projections for the AC Transit system, consideration was given to the future volume of child and student riders and an additional increment for advertising revenues. It is estimated that the number of these 15¢ passengers on the AC Transit system in 1975 will be 17,179,500. At the 15¢ rate, revenue from these passengers will add $2,576,925.

Adding the yield from these and advertising to the adult figures developed above, Fare Plan A-2 is expected to produce annual revenues of $10,607,791 from 60,414,714 passengers (Table 65).

Summary of Revenue and Passengers for Bay Area Transit Systems in 1975 Under Machine Run VI

The passenger and revenue volumes under Machine Run VI projected for each of the Bay Area transit systems are summarized in Tables 63 and 65. The first of these tables deals solely with adult riding and revenues, while Table 65 includes child and student riding and advertising income as well as adult patronage. Table 65, therefore, reflects total patronage and passenger plus advertising revenue.

The BARTD operation is expected to carry 53.9 million adult riders under Fare Plan B-4, of whom 36% will be transbay passengers, about 40% San Francisco riders and the balance —approximately 24%—riders on the East Bay portion of the BARTD system. BARTD's share of total adult riding on Bay Area transit systems will be approximately 19%.

When child, student and advertising revenues are added, the BARTD total for 1975 reaches $25.7 million, and riding aggregates 56.6 million passengers.

In terms of adult patronage, the Muni system is expected to carry two-thirds of 1975 area transit patrons. It will be noted that Muni is expected to become primarily a rapid transit and rapid transit feeder system. Under Fare Plan M-3, adult passengers on the Muni Rapid lines will total 42.5 million annually, while surface riders in conjunction with BARTD and Muni Rapid trips would aggregate an additional 88.9 million riders. Trips confined solely to the surface lines are estimated at 57.8 million annually—only about 31% of the Muni system total.

Muni system revenue—including child, student and advertising revenues—will total $35.3 million and passengers will aggregate 208.5 million annually.

The AC Transit operation is expected to carry 43.2 million adult riders in 1975, 15% of total transit traffic in the Bay Area. Most of these (57%) will be riding AC Transit bus lines to or from BARTD.

Child and student riders now represent a larger proportion of AC Transit patronage than is true on Muni. This difference will be even more pronounced in 1975. When children and students are added to projected adult riding on AC Transit, total riding is estimated for 1975 at 60.4 million passengers while revenue reaches $10.6 million annually.

The overall expectation is that 325.5 million patrons will use Bay Area transit systems in 1975, based on the proposed network of transit routes and fare plans under Machine Run VI. Passenger and advertising revenue would aggregate $71.6 million, a gain of more than $9 million over the aggregate yield previously detailed for the same three systems under Machine Run V.

SHARING THE JOINT FARE DISCOUNT AMONG BAY AREA TRANSIT SYSTEMS

There is no single approach which will yield a '100% correct' answer to the matter of sharing the joint fare discount among the affected transit systems. Any formula which evolves will depend on the point of departure used in its development. The amount to which a surface system is entitled for carrying a joint-fare rider could be developed, for example, in relation to length of ride and fare charged for non-feeder trips on that particular system. An alternate approach would relate the cost of carrying a feeder-line passenger to the average cost per passenger on the entire surface operation. Another fundamental variation would relate average length of ride for feeder passengers on a

Table 65

BAY AREA TRANSIT SYSTEMS
1975 Annual Adult, Child and Student Passengers,
Passenger and Advertising Revenues
Under Machine Run VI

System (Fare Plan)	Adult, Child and Student Passengers	Passenger and Advertising Revenue
BARTD (B-4)	56,552,832	$25,723,433
Muni Rapid (M-3)	44,634,798	11,052,428
Muni Surface (M-3)	163,862,047	24,253,232
Muni System Total	208,496,845	$35,305,660 (a)
AC Transit (A-2)	60,414,714	$10,607,791 (b)
TOTAL	325,464,391	$71,636,884

(a) It is estimated that special and charter revenues will add $300,000 annually to the line passenger and advertising revenues shown here.

(b) It is estimated that charter revenues will add $800,000 annually to the line passenger and advertising revenues shown here.

particular surface system to length of ride on the rapid transit line to which feeder passengers are delivered. These several approaches would, individually and in various combinations, yield a wide variety of formulae for the sharing of joint fares. Valid arguments can be presented for or against any particular formula. The task is essentially one of judgment in the balancing of conflicting considerations.

All that can be done at this juncture is to suggest an approach which weighs the various considerations as they now appear. The eventual arrangement among the several transit systems will depend upon how much feeder surface operation the BARTD system requires and how much is realized in terms of fare box revenues in the aggregate by reason of that service.

It must be recognized also that the matter of sharing the fare discount is intimately related to the level of the fare structure on the surface lines. A realistic approach is to deal with the problem on the basis of present fares on the surface systems, together with the 25¢ basic or minimum fare which is expected to apply on BARTD. Discount sharing under various revised fare structures can then be viewed in relation to that considered appropriate under existing fares. This involves, therefore, the present combination of a 15¢ fare on Muni, a 20¢ minimum one-zone fare on AC Transit and a 25¢ basic rate on BARTD. In the light of these existing fares, it is felt that the appropriate feeder fare to be paid by a passenger on either AC Transit or Muni surface lines should be 10¢. This represents a 5¢ discount below the present fare on the Muni system and a 10¢ discount below the minimum on AC Transit.

As indicated above, a variety of arguments can be advanced as to the bases on which this 5¢ or 10¢ discount should be shared between the systems involved. On the one hand, it is a fact that passengers riding Muni or AC Transit to or from BARTD will, on the average, be riding considerably shorter distances than patrons using either of these surface systems for non-BARTD journeys. It is expected that patrons on both Muni and AC Transit using them for a BARTD-feeder leg will average less than half the trip distance on surface lines traveled by those passengers using surface lines for trips unrelated to rapid transit.

On the basis of length of ride for BARTD-related vs. non-BARTD trips on Muni and AC Transit, particularly when related to present surface fares, one could justify a total payment to either surface system of 10¢ or even less. However, while it is true that surface feeder legs will ordinarily involve short rides, a higher-than-normal proportion of BARTD-feeder trips will be peak-hour travel—trips occurring at a period of the day when it is necessary for the surface systems to add manpower and vehicles in order to take care of BARTD patrons. On the basis of cost of service, therefore, it may be held that the surface lines are entitled in many instances to full fares for feeder patrons carried to rapid transit.

These two basic elements—length of haul on the one hand and proportion of peak-hour patronage on the other—are important counterbalancing considerations. It is impossible, in our judgment, to refine the long-range predictions of patronage on surface lines to and from BARTD with the precision needed to resolve the relative impact of these two factors. Even if these projections were sufficiently accurate, differences in approach could remain an insurmountable barrier. For the purpose of completing the revenue projections, it was assumed that the discount represented in the surface feeder fare to BARTD below the present fare levels on each surface system would be divided equally between BARTD and either Muni or AC Transit, as the case may be. Thus, using existing fares as the basis, a passenger riding a Muni surface line to reach BARTD and/or after leaving BARTD, would pay 10¢ to Muni. BARTD would pay Muni an additional 2½¢ for each such rider, representing 50% of the discount in the feeder fare below the present 15¢ fare level on the Muni system. On AC Transit, the basic fare is 20¢, while the feeder patron to BARTD would pay 10¢. This discount of 10¢ would be borne equally by AC Transit and BARTD, requiring a payment of 5¢ per passenger by BARTD to AC Transit.

In order to illustrate the effect of this discount-sharing proposal, a series of six fare plans is summarized in several tables dealing with Muni, AC Transit, and BARTD combination fares (Tables 66, 67 and 68). These six fare plans are designated by the letters A to F inclusive, and incorporate a 15¢ fare on Muni in the first two plans, a 20¢ Muni fare in the second two plans and a 25¢ rate in the third pair of fare schedules. Plans A and B have not been applied to AC Transit, since they involve a 15¢

minimum fare—5¢ below the present AC Transit basic rate. Therefore, the AC Transit system schedules (Table 67) begin with Plan C; this illustrative plan as well as the three succeeding are the same as corresponding plans for the Muni system, i.e., 20¢ under Plans C and D and 25¢ under Plans E and F.

Plans A and C on these tables reflect a 10¢ feeder fare on each of the surface systems for patrons coming to BARTD. Plans D, E and F involve various combinations of feeder fares. Plan F corresponds to Machine Run VI which is the schedule of rates previously reviewed for the 1975 Bay Area systems.

It has been proposed above that 10¢ is the appropriate fare to be paid by the feeder bus passenger on the basis of the presently existing fare structures on Muni and AC Transit. The discount to Muni passengers under this arrangement would amount to 5¢ each, or $1,885,000 annually (Fare Plan A on Table 66). On the basis of equal sharing, BARTD would pay Muni one-half of this total discount, or $947,000 annually.

The present situation on AC Transit with the application of a 10¢ feeder fare is shown under Plan C on Table 67. BARTD would pay AC Transit 5¢ per passenger, based on equal sharing in the 10¢ discount. BARTD, therefore, would pay AC Transit $1,083,000 in relation to the total discount on surface feeder rides of $2,167,000.

The three fare structures under Machine Run VI involve a 25¢ minimum fare for adult riders on all three systems. On the assumption that this plan ultimately is made effective and that the minimum fare becomes 25¢ for Bay Area adult riders, the amount which the *passenger* would pay for a surface feeder ride to BARTD would be increased to 12½¢, or one-half the basic adult rate on either of the surface systems. It is proposed in Chapter 14 that this be accomplished by selling the feeder transportation on the basis of 25¢ for a surface round trip.

If basic surface fares are raised to 25¢ as contemplated by this proposal, it is suggested that the *total* amount to be received by AC Transit and Muni for each patron carried in conjunction with a BARTD trip be established at 15¢. Both Muni and AC Transit would then be receiving 12½¢ from the passenger and would be entitled to an added payment of 2½¢ per passenger from BARTD for each feeder journey. Under the previously described Machine Run VI (designated as discount-sharing Plan F on the accompanying illustrative tables),

Table 66

MUNI SURFACE AND BARTD-FEEDER FARES AND DISCOUNTS UNDER SEVERAL FARE PLANS

		FARE PLAN					
		A	B	C	D	E	F
Fare:	Muni Surface	15¢	15¢	20¢	20¢	25¢	25¢
	BARTD	25	25	25	25	25	25
	Muni-BARTD	35	35	35	35	40	37.5
	Muni-BARTD-Muni	35	40	35	45	50	37.5
Discount:	Muni-BARTD	5¢	5¢	10¢	10¢	10¢	12.5¢
	Muni-BARTD-Muni	5	0	10	0	0	12.5
Payment:	BARTD to Muni	2.5¢	2.5¢	2.5¢	2.5¢	0	2.5¢
	(per passenger)	2.5	0	2.5	0	0	2.5
Total Annual Discount on Surface Feeders		$1,884,698	$1,669,777	$3,922,932	$3,462,165	$3,377,730	$4,839,600
BARTD to Muni Discount Share		$ 946,648	$ 834,889	$ 985,340	$ 865,541	0	$ 972,437

this arrangement would yield a BARTD payment to Muni of $972,000 annually and a BARTD payment to AC Transit of $566,000 annually—representing in both cases a payment of 2½¢ for each feeder patron carried by the surface lines.

One of the fare plans shown on Tables 66, 67 and 68—Plan E—was designed to avoid inter-system payments by BARTD to either AC Transit or Muni. This particular proposal would establish a 15¢ fare paid by the passenger for a feeder journey to BARTD and would involve a total 25¢ fare for a passenger using Muni both before and after a BARTD leg, or using AC Transit both before and after a BARTD trip. Among the six alternatives considered, Plan E would require the highest fares by passengers making any form of combination journey.

Effect on BARTD Revenues of the Several Discount Plans Tested

The BARTD revenues anticipated under each of the six fare plans here used for illustration are summarized on Table 68. The top portion of this table shows the revenues expected on BARTD before any sharing of the discount with the surface systems. In the lower portion, the discount payments to Muni and to AC Transit were computed in accordance with the formula described earlier. Finally, the net revenue to BARTD after the discount sharing has been indicated on Table 68. In the aggregate, BARTD revenue varies from a minimum of $22,170,000 under Plan A to a maximum of $25,151,000 under Plan E. In this latter plan, as previously indicated, there would be no discount sharing with the surface systems and the feeder fare would be at a 15¢ level.

On the other hand, the proposal in Machine Run VI—Plan F in this table—yields $24,185,000 in net revenue to BARTD after payment of $1,538,000 in discount-sharing to Muni and AC Transit. Plan F is second highest in total revenues for BARTD among the six plans tested.

Net Effect of Discount-Sharing Plans on Muni and AC Transit

The impact of the six illustrative discount-sharing plans on AC Transit and Muni appears on Table 69. In the first column, the BARTD revenue after discount sharing with the surface lines has been set down from the preceding table. Table 69 then lists the Muni surface lines revenue, i.e., the revenues derived from adult surface riders and BARTD-related surface patronage, *plus* the discount-sharing payments from BARTD as contained in earlier tables. The

Table 67

AC TRANSIT SYSTEM
SURFACE AND BARTD-FEEDER FARES AND DISCOUNTS
UNDER SEVERAL FARE PLANS

		FARE PLAN			
		C	D	E	F
Fare:	AC Surface	20¢	20¢	25¢	25¢
	BARTD	25	25	25	25
	AC - BARTD	35	35	40	37.5
	AC - BARTD - AC	35	45	50	37.5
Discount:	AC - BARTD	10¢	10¢	10¢	12.5¢
	AC - BARTD - AC	10	0	0	12.5
Payment:	BARTD to AC	5¢	5¢	0	2.5¢
	(per passenger)	5	0	0	2.5
Total Annual Discount on Surface Feeders		$2,166,510	$1,955,550	$2,024,930	$2,817,690
BARTD to AC Discount Share		$1,083,250	$ 977,770	0	$ 565,620

Table 68

ESTIMATED EFFECT OF SEVERAL FARE PLANS ON
BARTD REVENUE

	FARE PLAN					
	A	B	C	D	E	F
BARTD Gross Revenue:						
Transbay	$14,014,305	$14,014,305	$14,014,305	$14,014,305	$14,014,305	$14,014,305
East Bay	4,728,480	4,728,480	4,728,480	4,576,742	4,753,121	5,041,365
San Francisco	5,456,727	5,391,590	5,756,312	5,568,450	5,416,219	5,678,400
Total Gross Revenue	$24,199,512	$24,144,375	$24,499,097	$24,159,497	$24,183,645	$24,734,070
Total Passenger and Advertising Revenue	$25,167,492	$25,110,150	$25,479,060	$25,125,877	$25,150,991	$25,723,433
Discount Payment: To Muni	$ 946,648	$ 834,889	$ 985,340	$ 865,541	$ -	$ 972,437
To AC	1,083,250	1,083,250	1,083,250	977,770	-	565,620
Total	$ 2,029,898	$ 1,918,139	$ 2,068,590	$ 1,843,311	$ -	$ 1,538,057
Net to BARTD After Discount Payments	$22,169,614	$23,192,011	$23,410,470	$23,282,566	$25,150,991	$24,185,376

Muni figures on Table 69 are confined to its surface lines and BARTD feeder passengers. The data do not include Muni Rapid passengers or those surface lines passengers riding in conjunction with Muni Rapid trips.

Muni surface revenue thus calculated varies from $15,102,000 under Plan A to a maximum of $20,843,000 under Plan E. The latter plan would involve a 15¢ one-vehicle feeder fare by the patron, or 25¢ for a Muni-BARTD-Muni journey and, therefore, is not recommended for adoption. Plan F, the scheme included in Machine Run VI, is almost as productive and much more attractive to patrons. It is expected to yield $20,375,000 in revenue, inclusive of the BARTD payment to Muni of $972,000 annually.

The AC Transit adult revenue, including payments from BARTD, are set down for Plans C through F on Table 69. The total amounts for AC Transit vary from $7,672,000 under Plan C to a maximum of $8,339,000 under Plan E. Again, Plan F appears to be the preferred arrangement, balancing revenue against passenger fares. Under this plan, AC Transit adult revenue, including the BARTD payment of $566,000 for carrying feeder patrons, would total $8,233,000.

Summarizing this discount-sharing analysis, it is felt that Plan F is the most satisfactory compromise. Fare Plan E in Tables 66 through 69 may yield greater revenue for each of the systems, but at the price of a 15¢ or 25¢ feeder fare for BARTD patrons using either Muni or AC Transit. In our judgment, it would be preferable in present planning to hold the surface line charge to half-fare, or 25¢ for a round-trip feeder journey. This fare schedule is believed to represent the best balance between high dollar revenue and the necessity to offer an attractive discount to the patron.

It will be seen later, in equating these revenue yields with operating costs, that the most satisfactory arrangement includes a 25¢ minimum fare schedule on both Muni and AC Transit, with the two surface systems receiving a 15¢ total payment for the feeder rides. This is best obtained by holding the price charged to the passenger at 12½¢ and having the additional 2½¢ payment made to these surface carriers by BARTD.

PROMOTIONAL FARES

Muni and AC Transit have a variety of special or promotional fare rates in their present tariffs.[6] It is anticipated that promotional fares will be included also in the BARTD fare structure.

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[6] Simpson & Curtin, *Technical Memorandum No. 52: Alternate Fare Proposals,* June, 1966.

The revenue estimates in this analysis for the BARTD system are based upon the point-to-point fares under each of the plans considered. If these revenue levels are to be achieved, discounts granted to regular patrons will have to be offset by corresponding increases in the cash fares for casual users of the service. Again, it becomes necessary to strike a balance on a discount rate which will be attractive to regular users, while at the same time holding casual rider fares close to those indicated in Fare Plans B-1 to B-4.

Reduction for Regular Riders

The most significant discount to be considered is the reduced rate for multiple-trip ticket buyers. This will have the greatest impact upon revenue. It is suggested that the reduced rate for regular users be confined to trips having a cash fare above 50¢, in the form of a multiple-ride ticket sold at 10 times the applicable cash fare but permitting one "bonus ride." Thus, 11 rides would be granted for the price of 10.

The saving available under this bonus ride ticket would range from approximately 5¢ to 9¢, depending upon the fare level involved.

Under BARTD fares contemplated in Plan B-4, 43.7% of riders would pay fares in the range of 55¢ to $1.00 and thereby be eligible for this regular rider discount. From analyses of similar discounts elsewhere, it is estimated that a ticket granting 11 rides for the price of 10 on the BARTD system will attract 50% to 60% of those patrons whose cash fare is at the 55¢-60¢ level; further, the proportion of discount sales will rise with the cash fare for longer journeys, so that passengers making trips in the 90¢-$1.00 cash fare bracket will use discount tickets in 85% to 90% of such instances.

Based on these proportions of discount riding under a ticket arrangement providing 11 rides for the price of 10, the average fare established under a particular plan for each point-to-point combination can be achieved by raising the cash fare 5¢ for the casual rider, thus providing the 9.1% discount as described above. For example, if an average fare of 75¢ is desired for a particular point-to-point journey, the cash fare for that journey would be set at 80¢ and the regular commuter permitted to buy 11 rides for $8.00, equal to a unit rate of 72.7¢. With 65% to 70% of the patrons using the discount rate, the average cash-commuter fare for this entire group would be 75¢.

Off-peak Promotional Fares

Traffic studies indicate that the proportion of BARTD patrons riding in peak hours will be greater than that on the Muni or AC Transit systems. The need for promotional fares to attract as many off-peak riders as possible will, therefore, be particularly significant. Fare rates affording reductions during the midday hours as well as on Sundays and holidays should receive careful consideration.

AC Transit now offers a 60¢ Sunday-Holiday pass which is good for unlimited rides by the holder on coaches in East Bay service, without limitation as to zones. These passes may be purchased from operators on the buses as well as at the downtown Oakland office of AC Transit. The price level on this daily pass is set at three times the minimum adult rate for a single-zone ride, and permits multi-zone riding at no extra charge. On the Muni system, the Sunday-Holiday pass is priced at 50¢, in relation to the 15¢ adult fare. It is proposed that consideration be given to a BARTD Sunday-Holiday pass priced at 75¢ for rides on the west side of the bay and at $1.00 for unlimited riding on the East Bay Lines.

Parking Charges at BARTD Stations

The revenue potential of parking fees at BARTD stations should not be overlooked. The initial program contemplates a parking lot accommodating 1,250 cars at Daly City and a total of 21,550 parking stalls at 22 stations on the East Bay. No parking will be provided at BARTD stations within San Francisco or at the downtown stations in Oakland.

A significant shortcoming in the planned parking facilities on BARTD is the absence of any parking at the outer stations within San Francisco. Those passengers coming up from areas south of San Francisco on the western side of the peninsula will have available to them the parking facilities at the Daly City Station. However, potential patrons along the southern portion of San Francisco, as well as below the San Francisco city line east of the San Bruno Mountains, who might wish to drive to BARTD rather than take their cars into the city will have no parking facilities. If BARTD is to serve the needs of this area adequately, it would appear that some parking facilities are required at the Balboa Station, adjacent to the Southern Freeway. While it may not be economically feasible to devote land area here or elsewhere in San Francisco to parking lots adjacent to BARTD stations, some opportunities exist to provide parking without using high-value land for this purpose. For example, there are Muni facilities at the Ocean Division immediately east of the BARTD station at Balboa. There is also the space above the Southern Freeway next to the BARTD station. Either of these areas could be decked over and parking facilities added without impairing present use to which this land is devoted.

There are valid arguments both for free parking and for a modest parking charge at BARTD stations. Quite obviously, free parking would result in the best competitive position for BARTD as against use of automobiles to downtown San Francisco.

On the other hand, a modest parking fee would be desirable to restrict the use of BARTD lots and to prevent their usurpation by employees and patrons of business establishments which may reasonably be expected to develop in the vicinity of BARTD stations. These stations will undoubtedly become focal points for commercial activity, including retail shops. Another consideration supporting a parking charge is the need for added BARTD revenues, to offset feeder bus line subsidies. Feeder routes to outlying BARTD stations will be at sufficient competitive disadvantage with autos in speed differences, without an added handicap of free parking. It is suggested, therefore, that a 25¢ parking charge be applicable at all BARTD stations.

Where excess space is available at some lots, a portion of that excess most distant from the BARTD station would be available as free parking, pending the development of additional BARTD patronage. The extent to which parking charges will be acceptable and feasible will depend upon circumstances at the various station locations. If there is a substantial amount of free and unrestricted on-street parking available in the station area, BARTD patrons are not likely to pay a fee when they are able to park at no charge. Unless the communities establish and enforce restrictions against long-term parking on the streets adjacent to the BARTD stations, it may not be practicable to apply a parking charge, except for a portion of the BARTD lots nearest to the stations where a charge for preferential space could be applied.

Conversely, in areas which are fully developed, the amount of on-street parking available to rapid transit patrons may be virtually nil. In these instances, the entire BARTD parking lot could reasonably be on a paid basis. In such areas, a parking charge would be necessary to

Table 69

EFFECT OF FARE PLANS
UPON OPERATING REVENUE

Fare Plan	BARTD Revenue After Discount Sharing	Muni Surface Revenue (a)	AC Transit Revenue (a)
A	$22,169,614	$15,102,404	Not applicable
B	23,192,011	15,182,034	Not applicable
C	23,410,470	17,317,472	$7,671,840
D	23,282,566	17,605,370	7,785,683
E	25,150,991	20,842,841	8,338,512
F	24,185,376	20,375,250	8,232,695

(a) Includes adult surface riders and BARTD-related patronage, plus payments from BARTD.

discourage the use of the lot by non-BARTD patrons.

Parking charges can be used to distribute rapid transit patrons among the BARTD stations in accordance with the supply and demand of parking at each. Where available space exceeds the demand, a substantial number of free stalls can be made available. At other lots where the demand exceeds the supply, it would be feasible to establish, for example, a 25¢ charge for most of the spaces and a preferential rate of 35¢ or 50¢ for the parking stalls nearest the station.[7] This arrangement would maximize the revenue yield from the parking facility and, at the same time, prompt some patrons to drive to alternate stations where excess space is available.

It would appear that no one policy or approach is appropriate to all stations. The approach should be flexible, suited to the circumstances in each area.

The revenue potential from parking fees can be indicated only in a general fashion. If 20,000 cars are parked daily and, in the aggregate, half of them are in paid stalls at 25¢, the daily potential is $2,500 and the annual revenue approximately $700,000. If circumstances are such that 15,000 cars are parked daily in the paid areas, the annual revenue potential would exceed $1,000,000.

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[7] It is possible that an electrically propelled automobile will be developed commercially by 1975. In such event, it would be advantageous to leave such vehicles on recharge at BARTD stations during midday hours, utilizing the excess power capacity of the rapid transit system. These recharge stalls would be at the close-in stations, with the power charge included in the parking fee.

CHAPTER 13

Operating Results in 1975

THE END RESULT of the fare analyses in the prior chapter was a distribution of riding on each of the Bay Area transit systems in 1975. To evaluate the proposed fare structures, singly and in combination, it was necessary to determine their sufficiency in meeting projected operating expenses. And, in order to project the cost of carrying the prospective passenger volume under each fare plan, it was necessary first to determine the amount of service required for that patronage and then to arrive at the cost of that service. Various methods were investigated for determining both of these sets of facts.

Determination of 1975 Service Levels

The number of adult passengers by lines under each projected fare plan served as the basis for estimating vehicle miles and hours of service to be operated on each surface route in 1975.

Service levels on existing routes were studied by class of lines to determine the mileage provided in relation to riding volumes. This was undertaken for Muni and AC Transit routes now functioning as arterials, crosstown lines or feeders. Examination of the present variations in service standards in accordance with route function and length of line served as the basis for estimating the annual miles of service to be provided per 1,000 passengers carried for those routes revised under the recommended plan. This process involved individual consideration of service levels on each of the 120 surface lines in the future transit network. In substance, this technique results in future service standards as nearly comparable as possible to those currently existing on the Muni and AC Transit systems. In the absence of alterations in the lines, the *present service standards were projected into the future and miles were increased or decreased in accordance with anticipated riding changes.* Where it was necessary to change the service standard by reason of a revision in the route function, this was done on the basis of examining present variations in service standards as among lines serving different purposes and having various lengths and speeds. It follows, therefore, that the projected volume of mileage involves a continuation of the existing service quantity in relation to patronage on the routes of Muni and AC Transit.

In some instances, of course, the nature and function of individual routes will change materially under the recommended future network. Some routes which are now bus arterial lines will be converted to rapid transit feeders and will be considerably shortened. Others which are now arterials will continue to serve that function but will also provide feeder service to rapid transit at one or more locations. Many routes which are presently feeder lines will continue as feeders with changes necessary to service new rapid transit facilities.

Having determined the annual miles to be operated on each route by this projection of existing service standards, vehicle hours were readily developed through the use of average speeds calculated for each route by the network coding procedure. Aggregate miles were divided by network speeds to arrive at annual vehicle hours. Where no material change in a surface line had been made under the coordinated plan, the future speed was, of course, similar to that presently operated on the line. In other instances where the route was changed, the determination of new operating speeds was a function of speed on each link of the new route. Therefore, as with the mileage to be operated, the future average speed becomes primarily a function of surface speeds presently accomplished on each system.

Forecasting Future Surface Transit Costs

Cost allocation models for the prediction of route operating costs were developed in Chapter 6 on the basis of five independent variables—vehicle miles, vehicle hours, peak vehicle needs, passenger revenue and miles of line. The degree of accuracy provided by this procedure is useful for analyzing current service, particularly in determining the margin between operating revenues and expenses for arterial routes, feeder and shuttle connections, etc. These "five variable" formulas for various types of service provide more accurate measures than any formula relying on a lesser number of independent variables. However, when applied to a future set of circumstances, this technique requires a prediction of future peak-hour vehicle requirements for each separate line. The estimating process necessary to obtain this variable on a route-by-route basis introduces additional areas for estimation which are, in fact, less accurate than the final formula itself. To obtain peak vehicle needs on a route, even on an estimated basis, the analyst must develop its round-trip running time, maximum load point, the peak hour-peak direction volume at the maximum load point and vehicle load factor. The prospects for error inherent in introducing these added variables to estimated peak vehicle needs made it advisable to re-examine these equations and develop a formula for future route costs using fewer variables while maintaining a satisfactory level of accuracy.

Sensitivity tests on cost allocation formulas with fewer variables indicate less than 10% deviation between "three variable" and "four variable" equations for allocating transit costs in the Miami urban area.[1] Based on these analyses, it was decided that cost allocations for Muni and AC Transit routes could be more directly and accurately made for 1975 on the basis of vehicle miles, vehicle hours of service and passenger revenue. Therefore, the formulas for forecasting 1975 route costs were modified as follows, with C being the daily cost of route operation in 1967 constant dollars:

Muni Bus:

$$C = 6.359H + 0.3862M + 0.11456R$$

Muni Trolley Coach:

$$C = 6.108H + 0.3803M + 0.09462R$$

Muni Cable Car:

$$C = 11.058H + 2.461M + 0.19624R$$

AC Transit Bus:

$$C = 6.209H + 0.2541M + 0.03865R$$

No change was made in the streetcar cost equation since these vehicles were eliminated under the rapid transit proposal. If future streetcar costs are to be considered, the formula previously cited in Chapter 6 is available, with route mileage and number of vehicles fixed at current levels.

Unit Costs for Projection of Surface Lines' Expenses—In preparing final unit costs for projection under the integrated system, two sets of adjustments were made in the 1965 fiscal figures for Muni and AC Transit. The first of these was to normalize the base year costs in order to eliminate exceptional or non-recurring items.

The second step in developing the unit costs for future projection was to update the normalized 1965 costs to reflect known cost changes for the fiscal period July 1, 1966 to June 30, 1967. No attempt has been made to apply an inflation factor beyond this fiscal period on each property, i.e., the year ending June 30, 1967.

Unit Costs for Muni and AC Transit Projections—Applying the modified formulas outlined above, approximately 60% of aggregate costs were projected on an hourly basis, about 35% on the basis of vehicle miles to be operated, and the balance on passenger revenue. The unit costs for projection on the AC Transit system were $6.209 per vehicle hour and 25.41¢ per vehicle mile. For the Muni bus lines, the corresponding costs for projection purposes were $6.359 per bus hour and 38.62¢ per bus mile.

The total cost per mile on the AC Transit system in the base year (1965) was 65.3¢. With the effect of known cost changes in the interim for AC Transit, the aggregate cost per mile in the projection has been increased to 72.3¢. On the Muni system, the base year costs for buses aggregated 93¢ per mile while the projected level of aggregate costs yields a figure of $1.076. On the trolley coach operation, the increase is from $1.05 in the 1965 fiscal year to $1.191 in the projection. For the cable cars, the increase is from $4.97 per mile to $5.37 per mile. *On an overall basis, the unit cost increase reflected in projected levels for 1975 is approximately 11% above the base year for the AC Transit system and 14% higher for the Muni sytsem.*

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[1] Simpson & Curtin, *Technical Memorandum T 1: Transit Cost Allocation Model Development,* Miami Urban Area Transportation Study, (March, 1967).

1975 OPERATING COSTS FOR AC TRANSIT AND MUNI SURFACE SYSTEMS

On the basis of passenger volume projected for each fare structure in the prior Chapter 12, the service to be provided on each surface route of Muni and AC Transit was determined in accordance with the method outlined above. The aggregate miles and hours of service were then priced on the basis of future unit costs per formula. The end result was to produce individual route cost figures[2] for the AC Transit and Muni surface systems.

Future Cost/Revenue Margins for Muni Surface Routes

Projected Muni adult passenger revenue under Fare Plan M-3, together with advertising income, is shown in Table 70, in relation to estimated 1975 operating cost for each surface line. For the Muni surface system as a whole, revenue per mile was projected at 73.0¢, while unit cost would aggregate $1.177.

The surface lines' excess of cost over revenues in 1975 is anticipated at 44.7¢ per mile. This compares with a loss of about 31¢ per mile on the Muni system in fiscal 1965 and a loss of 59¢ per mile on Muni lines classified as feeder routes in this period.

A major factor contributing to this operating loss is the high proportion of prospective traffic in low-fare feeder service. Approximately 60% of adult riders on Muni in 1975 under the recommended system will be making feeder trips to reach Muni Rapid or BARTD. As a result, six out of 10 riders will be paying only 5¢ or 12½¢, respectively, on these surface routes. While the base fare under proposed Fare Plan M-3 is 25¢—10¢ more than the present fare—nevertheless, the *majority* of Muni surface riders will be paying a lower fare than they do at present.

Future Cost/Revenue Margins for AC Transit Routes

Route operating costs in relation to 1975 adult passenger and advertising revenue under Fare Plan A-2 for each route on the future AC Transit system are set forth on Table 71. Adult passenger and advertising revenues are expected to produce slightly over $8 million while operating expenses will aggregate $14.3 million, resulting in a loss of $6.3 million on adult patronage. This figure will be later modified to take account of fares from children and students and the proposed fare adjustment from BARTD for discount sharing.

57% of these adult passengers on AC Transit lines in 1975 are expected to be riding buses to and from BARTD. Hence, AC Transit will receive the full fare from only 43% of adult patrons. Revenue per mile is projected at 45.2¢ in relation to unit operating costs of 80.8¢. Therefore, the AC Transit operation is expected to lose 35.6¢ per mile in 1975, prior to the two adjustments mentioned above.

Since AC Transit will be essentially a feeder operation in 1975, it is interesting to compare the anticipated results for that future period with the feeder lines of AC Transit under the current route pattern. In the year ended June 30, 1965, feeder routes on AC Transit produced revenue of 29.9¢ per mile in relation to operating costs of 66.5¢ per mile. This resulted in a loss of 36.6¢ per mile for the feeder portion of the AC Transit system. Therefore, the prospective results of operation for the entire system in 1975, when it will be essentially a feeder operation, are anticipated to be substantially similar in end result to the feeder route portion of the existing system.

1975 OPERATING COSTS FOR BARTD AND MUNI RAPID TRANSIT SERVICE

To determine the cost of service in 1975 on the two rapid transit networks, it was necessary first to project the estimated level of aggregate mileage on each system and then to apply to that mileage a unit cost reflecting the prospective level of operating expenses.

Future Level of Service

In projecting mileage to be operated on the Muni Rapid system, the level of service on each of the three Muni Rapid lines was developed without construction of a detailed schedule of operations on each route. The method was to determine the estimated volume of passengers passing through the maximum load point on each line and, by application of loading standards in the peak and off-peak hours, to estimate the number of car passes required at various periods over the entire service day. These individual car passes were then multiplied by

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[2] No attempt was made to distribute the child or student riders to individual lines. Route cost data were confined to the adult patronage in order to permit comparison with the route revenue figures presented in Chapter 7.

Table 70

OPERATING RESULTS FOR MUNI SURFACE ROUTES IN 1975 UNDER FARE PLAN M-3

Route No.	Adult Passenger and Advertising Revenue	Operating Costs	Operating Margin	Revenue per Mile	Cost per Mile	Margin per Mile
J	880,569	1,113,999	233,430-	.917	1.161	.244-
K	121,828	168,098	46,270-	.698	.963	.265-
L	81,733	228,517	146,784-	.337	.942	.605-
M	143,432	305,958	162,526-	.452	.963	.511-
N	144,393	345,572	201,179-	.398	.953	.555-
1	2,006,058	2,036,873	30,815-	1.212	1.231	.019-
3	881,542	944,351	62,809-	1.191	1.276	.085-
5	552,821	737,322	184,501-	.800	1.067	.267-
6	396,469	625,296	228,827-	.699	1.102	.403-
10	223,390	621,677	398,287-	.367	1.023	.656-
14	807,714	943,959	136,245-	.941	1.100	.159-
15	2,116,605	4,154,404	2,037,799-	.516	1.013	.497-
17	17,881	59,733	41,852-	.284	.949	.665-
18	89,916	480,991	391,075-	.169	.902	.733-
19	238,432	318,125	79,693-	.985	1.314	.329-
21	186,124	227,060	40,936-	.925	1.128	.203-
22	712,820	944,020	231,200-	.980	1.298	.318-
23	158,535	394,930	236,395-	.444	1.106	.662-
24	342,400	773,018	430,618-	.542	1.224	.682-
25	836,645	1,537,126	700,481-	.583	1.070	.487-
26	339,604	465,339	125,735-	.790	1.082	.292-
28	203,021	898,833	695,812-	.236	1.043	.807-
29	27,517	73,007	45,490-	.388	1.031	.643-
30	608,614	682,954	74,340-	1.142	1.282	.140-
30X	392,672	549,590	156,918-	.667	.934	.267-
31	177,361	270,688	93,327-	.691	1.054	.363-
32	136,145	177,807	41,662-	.886	1.157	.271-
34	32,992	235,034	202,042-	.135	.964	.829-
35	78,652	256,293	177,641-	.340	1.109	.769-
36	28,105	153,884	125,779-	.180	.985	.805-
37	224,759	1,007,575	782,816-	.235	1.055	.820-
38	1,853,164	1,745,320	107,844	1.268	1.194	.074
39	8,538	25,200	16,662-	.481	1.420	.939-
40	331,685	677,276	345,591-	.640	1.307	.667-
41	471,983	532,638	60,655-	1.080	1.218	.138-
41X	402,315	624,050	221,735-	.612	.949	.337-
43	83,798	413,184	329,386-	.212	1.046	.834-
45	165,869	150,054	15,815	1.458	1.319	.139
47	283,914	597,621	313,707-	.623	1.312	.689-
51	319,476	1,022,251	702,775-	.331	1.060	.729-
53	53,047	144,425	91,378-	.394	1.074	.680-
55	705,522	650,012	55,510	1.406	1.295	.111
59	1,651,147	2,273,891	622,744-	4.076	5.614	1.538-
61	399,225	552,866	153,641-	3.895	5.393	1.498-
66	33,074	147,293	114,219-	.219	.974	.755-
71	439,066	1,149,339	710,273-	.403	1.056	.653-
72	395,414	697,881	302,467-	.594	1.049	.455-
81	136,337	713,856	577,519-	.198	1.039	.841-
82	115,051	491,134	376,083-	.242	1.031	.789-
85	369,204	342,063	27,141	1.803	1.671	.132
15X	262,438	282,670	20,232-	.842	.907	.065-
TOTAL	21,669,016	34,965,057	13,296,041-	.730	1.177	.447-

Table 71

OPERATING RESULTS FOR AC TRANSIT ROUTES IN 1975 UNDER FARE PLAN A-2

Route No.	Adult Passenger and Advertising Revenue	Operating Costs	Operating Margin	Revenue per Mile	Cost per Mile	Margin per Mile
A	93,120	211,265	118,145-	.363	.822	.459-
B	172,914	258,758	85,844-	.497	.744	.247-
C	139,335	268,454	129,119-	.398	.766	.368-
N	59,845	66,910	7,065-	.606	.678	.072-
V	83,290	93,119	9,829-	.606	.678	.072-
E	19,070	32,434	13,364-	.459	.781	.322-
34X	315,562	515,982	200,420-	.442	.723	.281-
38X	103,059	268,472	165,413-	.290	.755	.465-
7	300,217	453,056	152,839-	.503	.759	.256-
11	129,895	316,691	186,796-	.397	.967	.570-
12	143,622	276,654	133,032-	.428	.825	.397-
14	434,044	869,563	435,519-	.417	.835	.418-
15	518,212	903,053	384,841-	.514	.895	.381-
17	39,890	274,880	234,990-	.138	.949	.811-
18	340,338	578,154	237,816-	.513	.871	.358-
40	721,976	757,024	35,048-	.704	.738	.034-
42	178,183	315,662	137,479-	.461	.817	.356-
46	52,399	183,011	130,612-	.220	.767	.547-
87	8,833	16,811	7,978-	.414	.788	.374-
51	561,754	822,414	260,660-	.637	.932	.295-
53	81,707	224,139	142,432-	.336	.921	.585-
54	39,404	99,037	59,633-	.331	.831	.500-
55	73,816	376,948	303,132-	.154	.786	.632-
56	175,050	287,311	112,261-	.474	.777	.303-
57	180,648	389,654	209,006-	.382	.823	.441-
59	65,100	136,963	71,863-	.382	.804	.422-
63	44,113	96,056	51,943-	.361	.785	.424-
64	80,886	144,481	63,595-	.532	.950	.418-
67	204,950	689,892	484,942-	.246	.828	.582-
68	60,445	207,600	147,155-	.221	.759	.538-
69	107,941	217,459	109,518-	.356	.718	.362-
70	2,807	4,059	1,252-	.505	.730	.225-
72	385,945	345,395	40,550	.922	.825	.097
74	40,254	128,871	88,617-	.262	.839	.577-
78	174,078	524,047	349,969-	.260	.782	.522-
79	119,481	462,728	343,247-	.207	.802	.595-
80	892,034	1,078,613	186,579-	.641	.776	.135-
83	182,604	250,325	67,721-	.626	.859	.233-
88	69,824	86,289	16,465-	.758	.937	.179-
90	23,743	48,842	25,099-	.387	.795	.408-
92	9,927	25,363	15,436-	.302	.770	.468-
91	57,548	122,061	64,513-	.371	.786	.415-
93	94,347	291,325	196,978-	.235	.727	.492-
W	20,725	25,431	4,706-	.568	.697	.129-
O	99,481	122,067	22,586-	.568	.697	.129-
F	18,146	30,435	12,289-	.496	.833	.337-
T	207,981	337,604	129,623-	.457	.742	.285-
CX	76,554	70,103	6,451	.758	.694	.064
TOTAL	8,005,097	14,305,465	6,300,368-	.452	.808	.356-

Table 72

MUNI RAPID SYSTEM
Annual Car Miles Anticipated for Each Route in 1975
Under Fare Plans M-2 and M-3

	Fare Plan M-2		Fare Plan M-3	
	Range of Annual Car Miles		Range of Annual Car Miles	
Muni Rapid Line	From	To	From	To
Richmond	2,846,100	3,415,400	3,119,300	3,743,800
Sunset	1,860,700	2,232,800	1,871,900	2,246,200
Twin Peaks	2,135,500	2,562,600	2,159,000	2,590,800
TOTAL	6,842,300	8,210,800	7,150,200	8,580,800

round-trip miles on the line to yield the daily volume of mileage. This total was annualized to produce the yearly miles on each of the rapid transit routes. In general, the loading standards applied were 120 passengers per car in peak period, 30 to 40 passengers per car in midday, with policy headways controlling in the late night hours.

On the basis of passenger volumes anticipated under Fare Plans M-2 and M-3 and the loading standards described above, a range of annual miles was determined for each of the Muni Rapid lines. These mileages appear on Table 72. In applying these annual mileage figures to determine operating costs, the midpoint of the range of annual miles was used under each of the fare plans.

The prospective level of service on BARTD was constructed from the mileage projections employed in the Composite Report.[3] That study projected passenger operation on BARTD at a level of 27.1 million car miles in 1975. This figure, however, was in relation to prospective passenger riding above the level of patronage anticipated in this NCTDP study. In our judgment, it is reasonable to expect some reduction in the previously planned service by reason of lower estimates of patronage. It was assumed, therefore, that aggregate BARTD service will be less than 27.1 million miles annually to the extent of one-half the percentage reduction in the patronage estimate from that contemplated in the Composite Report. For the passenger volumes developed in the prior Chapter 12 for BARTD Fare Plan B-4, service would total 23,442,000 car miles on the BARTD operation in 1975.

Unit Cost of Rapid Transit Operation

A detailed projection of unit operating costs for a proposed rapid transit system would require an in-depth analysis beyond the scope of this phase of the Northern California Transit Demonstration Project. Separate study would have to be given to a great many cost elements and to the considerations which bear on each of these different cost factors on the particular system being planned. Such a study has not been attempted in this instance for either BARTD or Muni Rapid.

It should also be observed that, regardless of the degree of refinement which may be applied in projecting costs, there is a substantial area of uncertainty introduced by the cost structure of the transit industry. Aproximately 70% of the aggregate cost of operating a rapid transit system is consumed in wages and other labor costs. The cost of rolling stock, electric power, maintenance plant, and a number of other items are capable of relatively precise prediction. However, all non-labor expenses account for only 30% of operating costs. Since labor expenses cannot be predicted with the same precision as physical elements of expense, there is a significant degree of uncertainty in any projection of rapid transit costs for a system not already in operation.

It is customary in this industry to express unit costs for rapid transit operation in terms of an amount per car mile, particularly in making comparisons among different systems.[4] Data were obtained on operating costs of the six rapid transit systems which have been in operation for some years on the North American continent—New York, Chicago, Philadelphia, Boston, Cleveland, and Toronto. A consideration of the factors bearing on costs on these six systems resulted in the selection of Chicago, Philadelphia and Cleveland as the three properties representing the most appropriate gamut for estimating future costs on BARTD and on Muni Rapid.

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[3] Parsons Brinckerhoff-Tudor-Bechtel *et al, op. cit.*

There are four major categories of direct cost in a rapid transit operation. These include (1) the conducting of transportation, (2) the maintenance of equipment or rolling stock, (3) the maintenance of way and structures, and (4) power costs. Normally, the cost of conducting transportation—nearly all a labor item—accounts for approximately half the direct operating cost of a system. The remaining three categories of expense are roughly equal—although there are variations from one property to another—and together account for the remaining half of direct operating expenses. In addition to direct charges, there are general and administrative expenses, many of which cannot be computed as precisely as the four categories described above. All existing rapid transit operations are part of integrated surface and rapid transit systems; this requires that general and administrative costs be allocated or apportioned between surface and rapid transit lines. The necessity to allocate means that these particular items cannot be determined as precisely as direct costs, since there are variations in the allocation techniques used on different systems. Nevertheless, it is possible to make a reasonable approximation of general and administrative expenses as a percentage to be added to direct operating costs of a rapid transit system. The comparative material on rapid transit costs considered in this study excludes taxes, depreciation, and debt service.

The operating cost per mile on the Chicago, Philadelphia and Cleveland rapid transit systems are summarized on Table 73. The sum of transportation, equipment maintenance, way and structures maintenance, and power costs amounts to 60.44¢ per mile, representing the average cost level for these three properties in 1965. There are differences in the accounting techniques used for general and administrative costs, and not all of the figures are available. It is estimated that injuries and damages plus other general and administrative costs add approximately 20% to the direct unit costs for the items identified above; this percentage was added to the 60.44¢ figure developed on Table 73 to arrive at the average direct cost plus general and administrative expenses. This yielded a total cost of 72.53¢ per mile on these three rapid transit systems at 1965 cost levels.

The cost levels reflected on this table then were increased to allow for changes in expense levels since the calendar year 1965. Steadily rising cost levels indicate that this figure of approximately 72½¢ in 1965 should be increased to 75¢ per mile to reflect the situation as it exists in early 1967.

Unit Cost for Muni Rapid Service—The average unit cost on these three properties provides a reasonable base for projecting expenses on the Muni Rapid system. It may be that the average speed on Muni Rapid will be slightly higher than the average on the Chicago, Philadelphia and Cleveland systems in combination—which would tend to reduce unit costs in San Francisco. On the other hand, it is reasonable to expect that wage levels on the San Francisco rapid transit system will be higher than the average prevailing in these three other cities. The latter consideration overbalances the speed factor; the aggregate effect of speed and labor cost considerations leads to an estimated unit cost of 80¢ per car mile for the Muni Rapid system at 1967 cost levels. This estimate of unit costs places the Muni Rapid system at a higher cost level than Chicago, Cleveland or Toronto, but below the unit cost prevailing in Philadelphia, New York and Boston. As previously noted, the unit cost of 80¢ per mile used herein for Muni Rapid cost projections includes nothing for depreciation, taxes, or debt service.

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[4] It is recognized, of course, that there are differences in equipment, wage rates, loading standards, maintenance facilities, age of the equipment and physical plant, operating speed, the rate paid for electric power, and a number of other elements accounting for variation in the cost of operating one system as compared with another. Notwithstanding these variations, the most reliable basis on which to make overall judgments for operating cost of a planned system is that which is now borne to operate existing properties. The inclusion of cost data for several systems makes it possible to develop a range for certain categories of expense which will lessen the distortion involved in the selection of any one property as the standard.

Unit Cost for BARTD Service—In using the experience in other cities as a guide in forecasting operating costs on BARTD, allowance was made for the fact that BARTD will operate at an average speed substantially faster than that prevailing on other major rapid transit systems. Consideration was given to reducing unit costs for those elements of expense which will be affected by speed; this relates most directly to the cost of conducting transportation.

BARTD will achieve an operating speed averaging slightly over 40 miles per hour, compared with typical speeds on other systems in the comparison gamut of 20 to 35 miles per hour. BARTD will also have the advantage of automation to reduce manpower requirements on trains. However, the increase in operating speed may not be fully converted into labor cost savings because of daily guarantees and other work rules customary in this industry. It was estimated that BARTD will, with the net effect of automation and higher speed, be able to achieve a unit cost for conducting transportation of 55%-60% of that on the systems in Chicago, Philadelphia and Cleveland. Expanding the figures on Table 73 to current levels, the cost for conducting transportation averaged 33.2¢ per mile on these three rapid transit systems. Thus, an estimated amount of 19¢ per mile was derived for BARTD costs in this category.

There is a considerable group of expense items which vary with mileage and will not be materially reduced in terms of unit cost through higher speed. Essentially, these fall under the categories of power maintenance of rolling stock (as opposed to daily servicing), the repair of track, ties, ballast, and other roadway costs which are primarily a function of the number of passes over the track. These several items related to mileage were estimated at 20¢ per mile out of the total 75¢ unit cost developed from Table 73, after expansion to current cost levels. Thus, this 20¢ unit amount would be carried over to BARTD with no reduction by reason of higher speed.

The two groups of unit costs described above are (1) those related more or less directly to hours of service and, therefore, on which unit costs are reduced as speed rises, and (2) those which are directly related to miles and will not be affected by speed. The remainder of costs are related in varying degrees to miles and/or hours. It was estimated that the BARTD unit value for these mixed items will be about two-thirds of that on the other three systems, or 14¢ per mile.

Total cost for BARTD service achieved by combining the three figures developed above was 53¢ per mile. This value of 53¢ per mile would be a reasonable estimate for BARTD on the basis of experience on existing systems in other

Table 73

RAPID TRANSIT OPERATING AND MAINTENANCE COST PER MILE:
Chicago, Philadelphia and Cleveland in 1965

	Unit Cost in Cents per Car Mile			
Cost Category	Chicago	Philadelphia	Cleveland	Three-City Average
Conducting Transportation	29.25¢	39.82¢	27.38¢	32.15¢
Maintenance of Equipment	10.67¢	11.37¢	6.74¢	9.59¢
Maintenance of Way & Structures	10.92¢	8.58¢	7.54¢	9.01¢
Power	8.86¢	11.51¢	8.69¢	9.69¢
Operating and Maintenance Costs per Mile	59.70¢	71.28¢	50.35¢	60.44¢
Allowance for General and Administrative Expenses — 20% of Direct Costs				12.09¢
Direct plus General and Administrative Expenses (a)				72.53¢ (a)

(a) No allowance included for taxes, depreciation or debt service.

cities. However, it assumes that labor and material cost levels for Bay Area rapid transit will be equal to the average prevailing in Chicago, Philadelphia and Cleveland. It is necessary, in our judgment, to anticipate an added increment in BARTD unit costs by reason of area differences in price and wage levels. Thus, for purposes of cost projection, a figure of 58¢ per car mile was applied to the BARTD operation.

PRO FORMA RESULTS OF OPERATIONS IN 1975—BARTD, MUNI SURFACE AND RAPID, AND AC TRANSIT SYSTEMS

With the coordinated route network and the recommended fare plan (B-4) described in prior Chapter 12, BARTD is expected to generate total revenue of $25,723,433 in 1975. Service on the BARTD system will aggregate 23,442,000 miles; at a unit cost of 58¢ per mile, operating expense was estimated at $13,596,360. After allowing for discount-sharing payments to Muni and AC Transit of $1,538,057, as developed under Plan F in Chapter 12, the estimated net operating revenue remaining would be $10,589,016. This is the amount available for debt service on rolling stock, depreciation, reimbursement of construction costs for approaches to the transbay tube, and appropriate reserves.

As a measure of sufficiency, this projection of operating results may be compared with corresponding estimates in the Composite Report, as follows:

	BARTD Operations in 1975	
	per NCTDP	per Composite Report
Passenger and Advertising Revenue	$25,723,433	$24,539,000[5]
Operating Costs, excluding depreciation and taxes	13,596,360	13,510,000
Discount-Sharing Payments to Muni and AC Transit	1,538,057	—
Net Revenue Available for Debt Service, Depreciation, Reimbursement of Construction Costs, and Reserves	$10,589,016	$11,029,000

While passenger revenue under the fare plan recommended by this project will yield nearly $1,200,000 more in operating revenue, the influence of higher operating costs and discount-sharing will more than offset this. As a result, the net operating revenue for BARTD in 1975 is $440,000 less.

The principal item to be supported out of net operating revenue of BARTD is financing the cost of rolling equipment. BARTD's financing plan is based on equipment purchases made through the medium of bonds secured solely by pledge of operating revenues of the system. The Composite Report indicates 430 cars will be required by BARTD in 1975 at a cumulative cost of $68 million. Debt service requirements for these revenue bonds are similarly projected at $6,613,000, at an assumed coupon rate of 4¾% and 25-year amortization. While the unit price of rapid transit cars may run somewhat higher than estimated, in line with prevailing inflationary trends, it can be reasonably expected that substantially less than 430 rapid transit cars will be required in view of the lower patronage and service levels derived in this study. Therefore, the net operating revenue projected here should provide generally the same degree of debt service coverage on revenue bonds as that contemplated in the 1962 Composite Report.

It should be pointed out also that any lesser fare plan than B-4 would be insufficient to sustain BARTD's financial requirements. As indicated in the prior chapter, the Composite Report fare plan (B-1) would yield approximately $4,800,000 less revenue than that which is recommended here; proportionately reduced amounts of passenger revenue would be derived under Fare Plans B-2 and B-3. With more than $10 million annually needed for debt service and other fiscal requirements, BARTD Plan B-4 becomes the logical choice.

Projected Operating Results for the Muni System in 1975

With its recommended fare plan—M-3—and a coordinated surface and rapid transit network as previously proposed, Muni is expected to have an operating deficit in 1975 of $6.95 million as follows:

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[5] This estimate of passenger and advertising revenue in the Composite Report includes consideration of reduced fare for combination trips involving surface feeder lines, but does not provide specifically for discount-sharing payments to Muni and AC Transit.

	Muni Rapid	Muni Surface Lines	Muni System
Passenger and Advertising Revenue	$11,052,428	$24,553,232	$35,605,660
Discount-Sharing Payment from BARTD	—	—	972,437
Total Revenue	$11,052,428	$24,553,232	$36,578,097
Operating Expenses	$ 6,292,400	$37,232,777	$43,525,177
Profit (Deficit)	$ 4,760,028	($12,679,545)	($ 6,947,080)

Revenue for surface lines shown on this table is based on the 25¢ fare (Plan M-3), plus an estimated $300,000 annually for charter and special revenues. The costs for Muni surface lines result from the individual route analysis of expenses developed previously in Table 70, plus an allowance for the cost of the charter and special service and added mileage required to accommodate the student and child passengers who were not reflected in the detailed route analysis.

It is noteworthy that Muni Rapid will be a profitable operation, producing net income of more than $4¾ million in 1975. Offsetting this will be the loss on Muni surface lines exceeding $12 - 2/3 million, part of which is chargeable to the Muni Rapid, since it includes feeder operations at reduced fares.

The net result after allowance for discount-sharing from BARTD is an annual loss of $6,947,080 in 1975. Similar calculations for the 20¢ fare plan on Muni surface lines—Plan M-2—produced $3,600,000 less passenger revenue and more than $500,000 greater operating expense by reason of increased mileage. The projected deficit for Muni under Plan M-2 would be over $11 million in 1975. In the light of this, and recommended fares on the other systems, it appears logical to maintain a basic fare of 25¢ on the three Bay Area systems.

This projected deficit of slightly less than $7 million is reasonably in line with the actual results of operation on the Muni system in the past few years, as follows:

1964	($7,277,240)
1965	(7,991,711)
1966	(8,446,868)

Projected Operating Results for the AC Transit System in 1975

Similar projections were made for AC Transit's reduced operations in 1975, based upon the recommended Route Plan E in Chapter 10, recommended Fare Plan A-2 and Fare Discount Plan F in Chapter 12, together with the cost formulae described previously in this chapter. The 1975 projection for these several components of the AC Transit system may be summarized as follows:

	AC Transit System
Passenger and Advertising Revenue	$11,407,791
Discount-Sharing Payment from BARTD	565,620
Total Revenue	$11,973,411
Operating Expenses	17,055,659
Profit (Deficit)	($ 5,082,248)

The adult revenue projected for AC Transit is based upon the 25¢ fare plan identified in Chapter 12 as Plan A-2, to which $800,000 has been added as an estimate of charter revenue. Operating costs are predicted on detailed route expenses developed previously in Table 71 for each of the AC Transit lines, plus an allowance for charter service and additional miles throughout the system to carry student and child passengers.

In passing, it should be pointed out that the net results of operation for AC Transit under Fare Plan A-1 projected a net loss of $1,150,000 greater than that shown in the foregoing table. In view of this, it was deemed advisable to urge a 25¢ fare plan for AC Transit in line with the recommendations on the two other systems.

On the basis of 25¢ minimum fare schedule on both Muni and AC Transit, it is felt also that the two surface systems should be entitled to a 15¢ *total* payment for the feeder rides, but that this can best be obtained by holding the price charged to the passenger at 12½¢ and having the additional 2½¢ payment made directly to the surface carriers by BARTD. This incorporates the discount-sharing plan reviewed in Chapter 12 as Plan F.

As shown above, projections for 1975 point to an operating deficit of more than $5 million on the AC Transit system, after payments from BARTD for discount sharing. As previously pointed out in Chapter 7, AC Transit system has been a deficit operation since the District came into being in 1960. And, while the District is widely acknowledged to be a very successful transit operation, that deficit has been increasing each year; the amounts drawn from tax proceeds for the past few years have been as follows:

1964	$1,980,926
1965	2,234,140
1966	2,344,783

The amount of deficit projected under the recommended system outlined above would be more than double the tax proceeds devoted to the AC Transit system in recent years.

Projected Operating Results for Bay Area Systems in 1975

Combining the three recommended networks and fare systems, it is estimated that transit operations will expand to a gross figure for passenger and advertising revenues amounting to $72,736,900 in 1975. Operating expenses of the three systems are expected to exceed this slightly; the sum of the three operating cost estimates aggregates $74,177,200.

This will leave a net areawide transit deficit of $1,440,300, which is well within the acceptance level of communities on both sides of the Bay in recent years.

Perhaps the most significant change to be considered is the projected increase in transit revenue for the Bay Area in the decade 1965 to 1975. Passenger and advertising revenue for the two existing systems aggregated $33,089,000 in fiscal 1965. It is anticipated in this study that transit operating revenues will rise to $72,736,900 ten years later—a projected increase of 120%. Part of this is due to fare increase and the rest to an overall capital investment of $1.5 billion to provide the most advanced areawide transit system in the world. While this growth projection may seem optimistic, it should be pointed out that the expectation inherent in it is a function of the attractiveness in speed and convenience of rapid transit, both as related to BARTD and Muni Rapid, rather than any generosity in projection assumption. What remains to make transit the outstanding growth situation of the Bay Area in this generation is for San Francisco to reaffirm its 1962 decision at the polls.

CHAPTER 14

Fare Collection

BARTD WILL CARRY more than 56.5 million passengers in 1975 under the recommended fare structure. Since each of these journeys will involve the passenger's coming to and going from BARTD stations, there will be a total of 113.1 million trip ends. This is the number of turnstile passes which passengers will make at the 33 stations on the BARTD system.

Most BARTD patrons, particularly those using the southern stations on the peninsula as well as most stations in the East Bay, will be beyond convenient walking distance. Patrons will have to use surface transit or autos to reach BARTD. As a result, surface transit will play a vital role in the delivery and distribution of BARTD patrons.

Nearly two-thirds of the access trips to and from BARTD will be by bus or trolley coaches. Under the proposed route network and recommended fare plan, it is anticipated that 74.4 million passengers annually will use surface transit lines in connection with BARTD journeys (Table 74). It is essential, therefore, that a convenient and efficient fare collection system be devised for joint riders. Particularly because it taps many areas with lower population density than characteristic of existing rapid transit systems, BARTD will be peculiarly dependent on a smooth and effective system of transit feeders. An important aspect of that system will be a fare collection plan for joint rides which is equitable, simple and easily administered.

PRESENT FARE COLLECTION METHODS

For coordinated Bay Area transit operations, it will be necessary to devise a collection method involving two manually collected fare systems —Muni's flat fare and the AC Transit zone fare—and a fully automated collection plan on BARTD with a fare structure based on varying station-to-station rates.

Muni Fare Collection Method

Fares on the Muni system are collected on a pay-enter basis, except on cable cars. The passenger pays the appropriate fare at the time of boarding the vehicle and transfers are issued upon request at that time. The vehicles are equipped with Grant lock-type, registering fare boxes. These fare boxes register cash only, although in former years when there were tokens in the fare structure, the boxes registered token fares separately.

At busy boarding points in heavy traffic periods, street collectors are used to permit passengers to board vehicles through rear door. These collectors use a hand collection system but register each cash fare.

On the cable cars, fares are collected by hand after the passengers board and are recorded on an overhead hand register.

School fares, restricted to grade and high school students, are in the form of a punch ticket. The operator or conductor punches the ticket in numbered spaces and issues transfers to students as requested, subject to the transfer regulations applicable to all riders.

Passengers riding on the Shoppers' Shuttle lines deposit their 5¢ cash fares in the fare box. No transfers are issued or accepted on these routes.

AC Transit Fare Collection Method

All cash and ticket fares on the AC system are deposited by the passengers in a non-registering lock-type fare box. In virtually all instances, fares are on a pay-enter basis.

Transfers are issued at the time the fare is paid, except on multi-zone rides. The multi-zone

Table 74
SURFACE TRANSIT PASSENGERS
TO OR FROM BARTD STATIONS IN 1975

BARTD Station	1975 Volume of Surface Passengers
Daly City	1,897,544
Balboa Park	4,092,543
Glen Park	4,029,102
24th Street	3,281,875
16th Street	3,327,660
Civic Center	3,998,579
Powell	4,122,767
Montgomery	22,543,305
Oakland West	853,992
12th Street	3,394,175
19th Street	1,831,855
MacArthur	1,303,321
Ashby Place	922,479
Berkeley	2,440,488
North Berkeley	674,737
El Cerrito Plaza	612,802
El Cerrito del Norte	716,722
Richmond	522,653
Rockridge	737,268
Orinda	71,550
Lafayette	91,585
Walnut Creek	180,021
Pleasant Hill	146,249
Concord	226,101
Lake Merritt	2,409,875
Fruitvale	3,763,958
Coliseum	1,487,638
San Leandro	1,783,626
Bay Fair	713,447
Hayward	1,524,560
South Hayward	172,130
Union City	262,565
Fremont	268,499
TOTAL	74,435,671

fare collection method involves the issuance of a colored "hat check" indicating the zone to which the passenger has prepaid his fare at time of boarding the vehicle. In the case of a multi-zone rider, the transfer is issued at the time the hat check is surrendered.

BARTD Automated Fare Collection System

BARTD plans a fully automated fare collection system. The method to be employed will involve the use of stored value or stored trip tickets which are magnetically encoded and are inserted by the passenger in entrance and exit turnstiles.

These tickets will be purchased from automatic vending machines with the purchased value or stored trips encoded in the ticket. When the patron enters a BARTD station, he will insert the ticket in the turnstile which records the location of entry into the transit system and returns the ticket to the passenger.

At destination, the passenger again will use the ticket to leave the station platform through a turnstile. Special equipment in the turnstile will "read" the point of entry into the BARTD system (the origin station) and deduct the appropriate value (or one trip on a stored trip ticket) from the ticket.

The process as now envisioned is fully automated. There will be no ticket agents, although the stations will be manned by personnel to assist passengers and provide travel information.

CRITERIA FOR PLAN SELECTION

The consultant worked closely with representatives of BARTD, Muni and AC Transit over a period of many months in researching various aspects of joint fare collection. FMC Corporation, as the subcontractor responsible for this work item, compiled a considerable body of background information on fare collection techniques throughout North America and Europe. FMC also developed several alternate systems for purposes of discussion, involving in some of the plans various special equipment and rather sophisticated collection techniques. In addition, representatives of BARTD, Muni and AC Transit met on numerous occasions to discuss the principles and operational problems involved under different joint fare collection plans.

The decisions on the collection system to be adopted have been in large measure influenced (and perhaps predetermined) by the criteria set up for the selection of that system. And the choice of weight given to criteria have been determined primarily by the operating systems which will administer the plan. It is hardly possible, therefore, to discuss and evaluate fare collection alternatives without defining the criteria to be applied.

The description of alternative collection systems in this report, with their advantages and disadvantages, represent an assemblage of the viewpoints expressed by the conferees on this topic. The conclusions with respect to each plan, however, are those of the consultant, and are based on the criteria defined herein.

Criteria for Selection of Fare Collection Plan

The criteria applicable to selection of the fare collection method for inter-system rides can be divided into two categories; one set of standards relates to the convenience of passengers and the other to administration of the plan by the transit systems. These may be enumerated as follows:

A. Criteria Relating to Passenger Convenience

1. Ease of Understanding—The system should be uncomplicated, oriented to use by women and children, and uniformly applicable to various groups of passengers to the maximum extent possible.
2. Simplicity of Operation—The scheme should be adapted to the physical convenience of riders and should accommodate direct flow.
3. Speed of Collection—The plan should provide for quick physical interchange and fast collection of the fare itself.
4. Convenience of the Majority—No plan can be devised which will be without relative disadvantage to some group of riders; therefore, the scheme ultimately adopted should be the most convenient and equitable arrangement for the majority of passengers. This is preferable to one which is complicated in an effort to embrace the requirements of every classification of patron.

B. Criteria Pertaining to the Transit Systems

1. Adaptability to Present Fare Plans—Consideration should be given to fare box limitations, the need for special equipment on the surface vehicles or elsewhere, the necessity to handle money from joint fare tickets and requirements of the fare plan in terms of the duties of vehicle operators.
2. Fraud-Proof—The plan selected should prevent misuse to the maximum extent possible.
3. Passenger Accounting—The plan should incorporate ready means of determining the number of joint riders and fares paid.
4. Adaptability to Fare Classifications—The plan should provide not only for adult riders but also for school students, children, and any other special fare classifications.
5. Speed of Feeder Service—An important consideration is the effect of the fare collection plan on operating speed; the method should not result in slowing the feeder operations.
6. Minimum Cost—Capital, maintenance and/or operating costs should be minimum consistent with the foregoing.

ALTERNATIVE METHODS FOR COLLECTION OF JOINT FARES

FMC Corporation conducted a survey of existing fare collection techniques in this country and elsewhere and suggested a series of alternative fare collection systems. In brief summary, the FMC alternatives were as follows:

Alternative #1: Stored value and transfer ticket approach.

This system is characterized by its ticket which stores dollar ride value that may be universally used to make trips on all transit conveyances operated by any of several different transit properties. It is fully automatic and involves inspection and collection of all joint fares by machine.

Alternative #2: Stored trip and transfer ticket approach.

The stored trip ticket entitles its holder to make a given number of transit trips between or within specified zones. It is also an automated system.

Alternative #3: Coin and stored ticket value approach.

This system involves automatic collection of coins and/or stored ticket value for transit rides. It involves the use of two machines on each surface vehicle. It is an automated system.

Alternative #4: Destination zone tokens.

This method is characterized by use of tokens which are obtained at entry points and permit automatic exit at specified exit points. It involves an exit gate at the rear door of the surface vehicle.

Alternative #5: Manual spot-check approach.

Under the spot-check system, passengers holding passes are normally free to enter and exit transit vehicles and stations unencumbered by fare collection procedures. However, a roving inspection team is always at work and if a passenger is caught without the proper ticket or pass by the team, he must pay a very stiff fine.

Alternative #6: Interline transfers and tickets.

This aproach employs a bus-rapid transit interline transfer and a zone-to-zone bus interline ticket.

Considerable attention was given to these FMC suggestions and to other arrangements for joint fare collection; it became evident, however, that the alternatives to be considered would be governed by two facts of overriding importance:

1. The BARTD fare collection plan will be fully automated. Hence, no joint plan can be devised which will involve manual or visual elements insofar as the BARTD legs of joint trips are concerned.
2. Muni and AC Transit have indicated a pronounced preference for a method or methods which do not require special machinery or equipment on surface transit vehicles.

Banks in some areas are introducing computer-based credit card and accounting systems which will minimize, if not obviate, the need for carrying cash, checks and other documents vulnerable to theft. First National City Bank is offering a charge service based upon an "everything card"—one card to carry, one bill to receive monthly, one check to write—for virtually anything a person may want or need, however trivial. If this card can be adapted for fare collection, it would be distinctly worthwhile to consider development of special equipment on surface vehicles to receive it. However, near-universal use in the Bay Area will have to precede any such development.

Meanwhile, if this fare collection study is to be of value to the several transit systems involved, it had to remain within the limiting considerations designated above. On this basis, three alternate schemes were designed to be compatible with the BARTD automated plan while at the same time functioning without special equipment of any type on the surface lines of Muni and AC Transit.

COLLECTION PLAN A

JOINT TICKET PLAN FOR COMBINATION RIDES

The identifying element in Collection Plan A is that passengers would buy their BARTD and surface feeder rides jointly—in one transaction. Such a plan could, of course, involve varying elements for different categories of passengers. Discussions among the parties developed alternative means by which some problems could be handled. These alternates will be described in connection with the class of rider to which they apply. The description deals first with joint riders (BARTD and surface lines) not using BARTD commute or multi-ride tickets. Subsequently, the plan will be described as it would apply to BARTD stored-trip ticket users.

Joint Passengers Not Using BARTD Commute or Multi-ride Tickets

The first group of passengers represents those who begin their journeys on a surface system (surface is used here to represent either Muni or AC Transit) and complete their trips on BARTD. These are single-ride passengers who do not have a BARTD commute ticket. Under Plan A, such a passenger would buy a combination ticket from the Muni or AC Transit operator. This combination ticket would be good for the minimum fare on both of the systems, i.e., on either AC Transit or Muni for the surface leg and BARTD on the second portion of the journey. Thus, the combination ticket would be good for a basic fare on the surface system and for a 25¢ ride on BARTD. The price of the combination ticket for a two-system ride would be something less than the sum of the fares on the two systems involved.

It would be possible to design a two-part ticket to serve this purpose, to be sold by the surface operator. At the time of sale, a stub would be removed from the ticket and placed in the fare box of the surface carrier as evidence of the transaction. The passenger would carry the remaining part of the ticket to BARTD. The ticket would be designed to permit the passenger to enter through the BARTD gate in the same fashion as a regular 25¢ ticket on the BARTD system. In other words, this portion of the combination ticket would be usable in the automatic turnstile of BARTD.

There are several methods which can be used to sell a joint one-way ride in a single transaction. One alternative would be to use a pair of tokens, of different size and/or color, one good for the surface ride and one for the BARTD continuation of the journey. Under this system, the passenger would pay the joint fare, deposit the appropriate token in the surface vehicle fare box and carry the second token with him for the BARTD journey. The BARTD entrance gate would be adapted to accept these tokens as a minimum fare payment.

A third alternative might involve the use of a token in the surface vehicle fare box as evidence of the transaction and the passenger could be given a magnetically encoded ticket to be used for the BARTD leg of his journey.

In discussions of Plan A with the surface carriers, it appeared that it would be necessary to have the surface operators account separately for the sale of joint fares. As a result, the money received by the operators for the joint rides would not be deposited in the fare box but would be hand-collected. The evidence of the transaction in the fare box would be a ticket stub or a token under one of the several alternatives described above. A method would have to be worked out to permit proper accounting for the joint fares, since all of the moneys for trips involving first a surface carrier and then a BARTD leg would be hand-collected by the surface carriers under this plan. With Muni using fare boxes which do not accommodate tickets, suggestions have been made for the installation of an inexpensive ticket receptacle on Muni vehicles for the depositing of the ticket stubs, or to have the operators collect such tickets by hand. In any event, some method satisfactory to the surface carriers as well as to BARTD would have to be developed in order to assure proper accounting for the moneys collected "over the fare box" in the sale of the joint tickets.

The foregoing discussion has dealt with a two-leg journey beginning on a local carrier and ending on BARTD. There is also the type of journey beginning on BARTD and ending with a surface ride. To accommodate passengers transferring from BARTD to a local line and enable them to secure the benefit of a reduced fare, patrons could pay the regular fare on BARTD and secure a transfer from BARTD to the local carrier at a predetermined rate. Such a plan would appear to present no major problems, providing proper equipment is installed in the BARTD stations. In order to avoid possible abuse, some arrangement would have to be made to be certain that an existing BARTD patron could buy only one of the surface fare tickets or transfers. This could be achieved by a device which would permit the sale of only one such surface reduced-rate transfer or ticket with each passage through the exit gate of BARTD.

Joint Riders Using BARTD Commute Tickets

BARTD commute riders who wish also to make use of either Muni or AC Transit in connection with their BARTD travel could purchase from BARTD a commute ticket (specially designed to distinguish it from regular commute tickets) and at the same time purchase a book of tickets or a supply of tokens good for the surface ride. Passengers when taking a surface ride would be required to show the BARTD commute ticket as identification when paying the surface fare. If a patron did not show the BARTD ticket, the surface fare tickets or tokens would be void.

Under this arrangement, the surface carriers indicated that special consideration should be given to the time limit, particularly on the BARTD tickets, in order to minimize possible abuse. Special consideration would have to be given also to the number of rides per ticket, the number being consistent with the time limit and, of course, the form of the ticket should be such that surface operators could easily identify the time limit. The equipment on BARTD would have to be so constructed as to recognize those time limits.

The discussions indicated that it may be necessary for BARTD to sell the joint commute and surface tickets manually. However, this was not fully explored; it may be possible to work out a plan which would permit automatic dispensing of joint fares.

One alternative suggested would provide for a joint BARTD-local commute ticket embracing on one ticket a predetermined number of rides both on BARTD and on the surface service. The operator on the surface service would cancel off one ride for each trip taken by use of a punch. This arrangement would require an additional section added to the regular BARTD commute ticket, extending one end of the ticket to provide a portion to be used in punching out the surface rides. This could be done and still maintain a reasonable ticket size, keeping one end and both sides of the commute ticket intact for use in the BARTD fare collection gate. The local carriers point out that this type of arrangement would provide no record on the surface vehicle of each ride taken. However, this should not be a major problem since the transportation would be prepaid at the time the ticket was purchased.

Arrangements for Three-Vehicle Journeys

If it should be desired to permit combination passengers to make journeys involving two surface trips and one BARTD trip—such as a BARTD trip between two Muni legs or between two AC Transit legs—with no added fare for the second ride on surface service, a special arrangement could be worked out. The passenger could pay the combination two-vehicle fare in the prescribed manner (under any of the alternatives described above) and at the same time secure a free surface transfer, retaining this transfer to be used for the second ride on surface service after completing the intervening BARTD portion of the trip. Consideration would have to be given to the advisability of having such transfers validated when passengers exit from BARTD and before taking the second surface leg in one direction. Such validation would be desirable to retain effective control of the transfer system on either Muni or AC Transit.

The transfer system mentioned above could function in the case of either a commute rider or a single trip or casual passenger. In fact, a transfer arrangement of this general nature appears to be the most practicable means of handling three-vehicle trips under any of the joint fare plans considered.

Advantages of Collection Plan A

The principal advantage of Plan A is that it permits a discount for all one-way combination rides involving the surface carriers and BARTD. There would be one cash transaction in each direction for the casual rider. Commute riders would be able to pre-purchase a supply of surface rides as well as BARTD rides in a single cash transaction.

A second advantage is that the plan is flexible. The amount of the combination fare can be established at any level, so long as it is greater than the one-way fare on the initiating carrier.

A third advantage is the possibility of using a surface-BARTD joint ticket which would be compatible with the BARTD automatic fare collection equipment.

Disadvantages of Collection Plan A

The description of Plan A above has been over-simplified in order to concentrate on the essentials of the system. It would, in fact, be rather complex. The first complexity arises from the need for a different joint fare arrangement for BARTD commute riders as opposed to those who are single-trip or so-called casual riders. Patrons would need to know both arrangements and choose that which would best suit their needs at any particular time. In addition, a joint ticket plan would require a separate type of combination ticket for children, for students, and for any other special fare classification, in addition to the regular adult commute and single-trip riders.

This plan requires that surface operators on Muni and AC Transit carry a stock of adult joint fare tickets, as well as any other combination tickets which may be needed for children, students, etc. Both Muni and AC Transit prefer a system under which surface operators are not required to carry and sell joint tickets.

Money from the sale of joint tickets on surface vehicles would be separately collected by the surface operators. A system would have to be devised for the accounting and turning-in of receipts for tickets sold by the surface operators. Operators on both surface systems would be hand-collecting money for BARTD under this plan—requiring a system of interline accounting for combination riders and the related payments to BARTD.

New ticket transactions on the surface vehicles superimposed on the present fare collection tasks would lengthen the time required for on-vehicle fare collection. Speed is essential in the operation of surface vehicles. It is clear that a plan requiring the sale by surface operators of various forms of joint tickets would be less desirable from the standpoint of operations than a plan not requiring such transactions. It would be slower.

Under any joint fare ticket plan, the passenger would purchase a ticket good only for a minimum fare ride on both the surface and BARTD services. It would be impossible, as a practical matter, to design joint tickets which would cover the large number of fare possibilities on BARTD. Hence, a patron using the joint ticket for a BARTD fare above the minimum 25 cents would have to perform another fare transaction on entering or leaving BARTD to add to the value of his ticket.

Finally, there is a basic problem in the joint fare arrangement for BARTD commute riders. As indicated in the description above, the patron buying a BARTD commute ticket would at the same time buy a corresponding supply for surface feeder transportation. This would be a supply of separate tickets or tokens or a punch ticket whereby one surface ride would be punched out for each trip taken. The number of surface rides would be keyed to the number of rapid transit rides pre-purchased. This means that the BARTD commute rider would benefit from reduced-rate surface transportation only through full utilization of surface feeder transportation. If the BARTD commuter desired to use an automobile or some other means of travel to or from BARTD on certain days during the period of his BARTD commute ticket, he would either lose one surface ride or, in the alternate, would not use his BARTD commute ticket on that particular journey but would ride as a casual patron in order to preserve the balance between rapid transit and surface trips on the combination ticket arrangement.

Conclusion With Respect to Collection Plan A

The essential advantage of this plan is that it permits a joint ride discount to one-way passengers under all circumstances. This advantage should be viewed in the light of the fact that only 2% to 3% of Muni surface passengers and approximately 3% to 5% of AC Transit passengers in 1975 are expected to be *one-way* passengers to or from BARTD. The remaining surface passengers will be either on trips which are not related to BARTD or will be taking round-trip journeys on BARTD and on the feeder surface lines.

While it is clearly desirable to make available a reduced-rate to all joint riders in either direction, it should be recognized that the multiplicity of arrangements and other problems involved in Plan A are actually being devised to take care of the 2% to 5% of surface patrons who would not be able to buy reduced-rate transportation under a collection system based on the round-trip principle.

COLLECTION PLAN B

UNBALANCED FARE TO AND FROM BARTD ON SURFACE FEEDERS

Plan B is designed to permit joint rides to be handled separately in each direction, but to grant a discount in one direction only. This scheme would involve the payment by the patron of the regular surface fare for his trip *to* a BARTD station. There would be no special transaction. He would ride in the same fashion as any other surface passenger, paying the regular fare on the surface line and then paying his BARTD fare in the normal manner. On the return trip, the patron would pay the BARTD regular fare but before leaving the controlled area of the BARTD station he would deposit a given amount (not less than 5¢ but it could be any amount below the regular surface fare) in a vending machine and receive a surface transfer or ticket which would be stamped with date and time. This transfer or ticket would entitle the holder to ride to the end of the first fare zone on AC Transit or to ride on a Muni surface line. The surface driver would check to be sure that the date is correct and that the boarding time is within the prescribed limits when accepting a transfer from BARTD.

A passenger wishing to use two Muni legs, before and after a BARTD journey, or a patron wishing to do the same on AC Transit, would be handled by a transfer plan. It will be noted that a three-vehicle trip of the type described in the previous sentence would require a 25-cent fare (under Machine Run VI) for the two Muni or for the two AC Transit vehicles used before and after a BARTD leg in *each* direction. Such a patron would be paying the regular surface fare for his surface transportation on the first vehicle, with free transfer privileges to a connecting surface line for continuation after riding BARTD. In fact, therefore, there would be no discount for the surface rides below the established surface fare, because the patron would *begin* his journey in each direction on the surface lines *going to BARTD* and would pay the regular surface fare at that time.

The only manner in which such a three-vehicle patron could be afforded a reduction would be to tie the two one-way three-vehicle trips into a round-trip arrangement which would entitle him to a discount. This could be accomplished, for example, by giving such a passenger a transfer at the time of paying his first surface fare which would entitle him to a *round trip* on another connecting surface line away from BARTD *and* returning to BARTD.

Thus, a patron would board Muni route A and pay his regular surface fare. He would request and receive a transfer with a detachable coupon.[1] He would enter BARTD at station X and pay his BARTD fare in the normal manner. He would validate his transfer in the BARTD station paid area upon alighting. The transfer would then be presented on Muni route B leaving BARTD station Y and the operator on route B would detach the coupon from the transfer.[2] The passenger would retain the transfer and present it when returning on route B toward BARTD station Y. It would be accepted as full fare and picked up by the operator. The passenger would then pay his usual BARTD fare, and on exiting from BARTD station X on his homeward trip would pay 5¢ for the final return leg on Muni route A. Thus he would have paid a total of 30¢ for his surface round-trip transportation involving four Muni vehicles on two routes. This is the same fare he would pay under this scheme for a round-trip surface journey to and from BARTD on a single Muni route, assuming the basic surface fare is 25¢ and 5¢ is set as the cost of a surface transfer away from a BARTD station.

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[1] The transfer could be punched if there is objection to a coupon plan.

The only special equipment involved in this method would be the transfer machines and validators to be installed within the paid areas of the BARTD stations. As with Plan A, the transfer vending machines would have to be so placed as to prevent any passenger buying more than one of the surface feeder transfers at the discount rate. As noted above, this could be done by installing the transfer machines in the exit area and permitting the purchase of only one surface transfer or ticket with each turn of the exit turnstiles.

Advantages of Collection Plan B

The main advantage of this plan is its simplicity. All passengers would be handled in the same fashion. Everyone traveling to BARTD would pay the regular surface fare. These passengers would ride in the same way and pay the same fare as any other surface patron.

In like manner, every passenger leaving BARTD and wishing to use surface transportation would be handled by one simple method. He would buy a surface continuation ticket or transfer by inserting 5¢ or some other given amount in a ticket issuing machine in the BARTD station.

Plan B would add nothing to the duties of the surface operators. The only change from the present arrangement would be the additional instructions to the operators with respect to the issuing and receipt of transfers involved in joint rides. Surface operators would handle no BARTD money. The money received by BARTD for surface rides in the station ticket-issuing machines would provide a complete record of the joint fare transactions. This sum would be turned over to the surface systems, plus or minus whatever amount would be necessary to achieve the agreed-upon division of revenues.

This plan is extremely simple not only from the standpoint of collection but in accounting as well. For example, if the surface fare is 25¢ and if it should be agreed that each surface system is to be entitled to a total of 15¢ for each feeder patron carried to or from BARTD, the 25¢ fare in one direction and 5¢ feeder fare in the other direction permits the entire transaction to be completed. The surface system would collect 25¢ in its fare box for the feeder leg to BARTD and would receive the full 5¢ collected by BARTD for the feeder legs originating from BARTD. With the payment of this full 5¢ to the surface system, both Muni and AC would have received 30¢ for a round-trip surface ride taken in conjunction with a BARTD trip. Thus, if BARTD were to turn over the moneys collected in its stations in the 5¢ surface ticket vending machines, the entire transaction would be closed at this point.

Plan B is the easiest method that can be devised—from the standpoint of the patrons and in administration by the several transportation systems. There would be no multiple tickets for any class of rider. With the exception of a three-vehicle rider who would carry a transfer from the first to the third vehicle (AC-BARTD-AC or Muni-BARTD-Muni) the passenger would not be required to carry over for any period of time a ticket or other evidence of his right to ride at a discount. The transfer arrangement for three-vehicle rides would be a part of any collection plan under consideration. It is the only practicable means of permitting a free ride on the second surface vehicle in a three-vehicle journey.

Disadvantages of Collection Plan B

The major disadvantage of this plan is the inherent problem of unequal fares for the same trip in two directions. In order for a patron to obtain the discount *which is intended* by Plan B, he must in fact be a round-trip rider. If for some reason, he rides a surface line only to BARTD and on his return trip gets to his point of origin by some other means, he obtains no discount under the plan. He has paid the full surface fare in order to reach BARTD. If the reverse of this is true, and he is able to get to BARTD by some other mode of transportation and then uses the surface line only when leaving BARTD on the return portion of his round-trip, he benefits from a very low surface fare, perhaps 5¢—a bargain far greater than is intended by the plan. In other words, the passenger who rides surface transportation in only one direction on his combination trip pays either too much or too little. The passenger who makes the surface feeder round-trip is the only one who pays the appropriate fare, i.e., the fare which is intended by the plan.

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[2] In the alternative, the transfer could be punched to indicate that the first use of it had been made.

The unbalanced fare in going to and coming from BARTD would be particularly significant where there are surface transit alternates available. Many journeys which will be taken on BARTD in combination with surface carriers could also be taken by using surface transportation entirely. The unbalanced fare would have the effect of diverting some of the combination traffic entirely to the surface lines in the direction where there is no discount for the patron under the fare plan. Thus, a person who would have to pay 50¢ for a one-way trip on either AC or Muni plus BARTD in the inbound direction (i.e., using the surface carrier first) might well decide to use surface lines entirely as an alternative in that direction. Assuming a 25¢ fare with free transfers on the surface systems, the passenger could make the trip for 25¢ on the surface as against 50¢ by using the surface feeder and then BARTD. This differential would divert a great many riders to the surface alternate. In the return direction, however, the

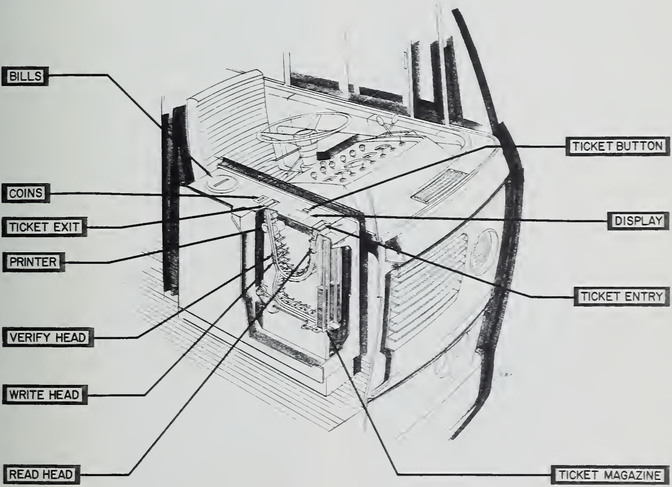


FIGURE 45

SCHEMATIC DIAGRAM OF TICKET VENDING EQUIPMENT
PROPOSED BY FMC CORPORATION FOR FEEDER BUSES

same passenger could obtain the joint ride for 30¢ (25¢ on BARTD plus 5¢ for the surface ride) and would very likely choose this faster alternative. The continued existence of surface transit alternatives in many instances is an important disadvantage of the unbalanced fare plan. Many patrons would undoubtedly use surface alternates for the inbound trip and the surface lines in combination with BARTD in the reverse direction where they are assured of a very substantial discount—a discount which is actually greater than is intended by this plan. There would be a major imbalance in riding on both the surface trunk lines and on BARTD. This imbalance would also affect vehicle and manpower requirements.

Conclusion With Respect to Plan B

Plan B achieves completely the objectives for which it was designed. It simplifies the procedure from the passenger's standpoint to the maximum possible extent. This plan minimizes —in fact it eliminates—any added duties to be performed by the Muni or AC Transit operators. It certainly would not impede operation of the surface routes in any manner. It permits simplification of the accounting procedures between the agencies to a very much greater extent than would be possible under any joint ticket arrangement such as that contained in Plan A.

Plan B is defective in that the unbalanced fare arrangement presupposes round-trip riding in order for the passenger to achieve the intended saving, but at the same time will operate to divert passengers by direction and thus to *reduce the proportion of round trips* under the combination fare. As noted above with respect to Plan A, approximately 95% to 98% of surface lines passengers in 1975 are expected to be either on non-BARTD related trips or on BARTD feeder legs which will be part of a round-trip surface and BARTD combination. Plan B, like Plan A, is designed to permit the joint fare journey to be made on a one-way basis. However, in achieving that objective, it affords no reduction in one direction and a very substantial reduction—actually an excessive bargain—in the reverse direction. As a result, Plan B would certainly result in a serious imbalance in riding with many passengers taking advantage of the surface alternative for the entire journey in the direction which would require payment of two full fares on the surface and BARTD systems.

COLLECTION PLAN C
ROUND-TRIP REDUCED-RATE SURFACE FARE

Plan C is designed to permit the purchase by the passenger of a round-trip surface feeder journey on either AC Transit or Muni, entirely apart from the BARTD fare collection procedure. It would permit the round-trip surface transportation to begin either on the surface lines or on BARTD.

There are three sets of circumstances which the fare collection plan must embrace. The first is that of a passenger beginning his journey with a surface feeder leg on either Muni or AC Transit and completing his trip on BARTD. The second situation involves the passenger beginning his trip on BARTD and completing it with a surface leg on either Muni or AC Transit. The third class of journey involves the use of a Muni vehicle to reach BARTD and then the use of a second Muni line to reach the final destination after leaving BARTD. Identically, this third type of journey would also involve an AC Transit-BARTD-AC Transit journey. The manner in which each of these three types of journeys would be taken care of under Collection Plan C is described below.

The fare plan which has been recommended (Machine Run VI) does not contemplate any joint fare tie-in between AC Transit and Muni with respect to surface feeders serving BARTD. Thus, a passenger using AC Transit to reach BARTD, crossing the bay and using Muni to complete his journey, would have entirely separate feeder surface transactions on each side of the bay. For purposes of the fare collection system, therefore, the three-system passenger would pay his feeder fare on each side of the bay as though he were not using more than two systems in his journey.

Muni-BARTD or AC-BARTD Round Trip

A passenger using either a Muni surface or AC Transit line to reach BARTD would pay regular fare on the surface system, and would be eligible upon request to receive a BARTD transfer or return ticket. This transfer or ticket would be good for the return ride on the surface line without extra charge (or together with an additional payment, if desired) provided the transfer had been validated within the

BARTD station paid enclosure by insertion in a validating machine installed for that purpose. A regular paper transfer could be used, but since it will normally be carried by the passenger throughout the day, a heavier paper stock might be preferable.

BARTD-Muni or BARTD-AC Round Trip

A passenger in this category would be initiating round-trip surface transportation from the BARTD station. Therefore, the passenger must obtain either a ticket or some necessary authorization within the BARTD paid area to permit a round-trip surface ride at a discount rate. Obviously, this authorization must not be granted without charge. In order to avoid abuse, some payment should be made for initiating the surface round trip from a BARTD station. So long as the passenger is required to deposit some money in the BARTD station to initiate the feeder round trip, there appears no reason to require two cash transactions. The entire round-trip surface fare from and to that BARTD station can be one transaction. Thus, the patron would insert, for example, 25¢ (the recommended surface fare under Machine Run VI), and would receive from a ticket vending machine within the BARTD paid area either a transfer or ticket good for the outbound trip from that BARTD station. The passenger upon presenting this transfer to surface line operator would be entitled to receive a transfer or ticket good for the surface trip in returning to that station.

The machine in the BARTD station, as an alternative, could issue a two-part ticket, one good for each direction on the surface line from and to the BARTD station. In either event, the ticket or transfer would be dated and time stamped when issued. In addition (as with Plans A and B) only one such transaction could be permitted with each passage through the BARTD exit gate.

Muni-BARTD-Muni or AC Transit-BARTD-AC Transit Round Trip

A passenger in this category would begin his feeder fare transaction in the same manner as the passenger in the first category described above. He would pay his full surface fare on the Muni line used to reach BARTD and would request a BARTD ticket or transfer from the originating surface operator. If he planned to continue after leaving BARTD by riding another Muni line, he would validate the BARTD ticket or transfer within the paid area of his exiting BARTD station. This validated ticket or transfer would then be shown (but not surrendered) to the operator on the Muni surface line going away from his exiting BARTD station.

When the passenger was ready to begin his homeward-bound three-vehicle journey, he would present the validated ticket or transfer on a surface line going toward the BARTD station identified on his validated ticket. The surface operator would lift this ticket or transfer and would issue the passenger a new BARTD ticket or transfer without charge. The passenger would then validate the new transfer or ticket in his exiting BARTD station in his homeward trip. The properly validated transfer or ticket would then be good for the completion of his surface transportation from that BARTD station.

While Muni has been used to describe the technique in this illustration, the same method would apply to an AC Transit-BARTD-AC Transit journey.

There are, of course, alternative methods which could be used for three-vehicle rides of this type. Transfers can be designed with detachable coupons for each leg of multiple journeys. These are used successfully on other systems. A third alternative would involve the issuance of a special transfer (a distinctive form) for the continuation, or third vehicle ride.

Advantages of Collection Plan C

Plan C has all of the advantages which have been identified above for Plan B, except that it is available only on a round-trip basis. Plan C would handle all classes of passengers on the same basis—regular or casual, adult, child, student, etc. It provides for the payment of the round-trip surface fare in one payment, whether that be made on the surface vehicle or in a BARTD station. Surface operators would not be required to sell joint tickets. They would do nothing that they do not now do, except to learn additional transfer rules for the issuance and the receiving of the transfers for joint rides. Plan C would not slow down the operation of the surface lines nor add to the duties of the surface operators. It would be necessary for the surface operators to collect BARTD-validated transfers or tickets accepted for free return rides on surface lines. These would be placed in a special envelope by the surface operator and would be used in determining the volume of such riding.

From the standpoint of the rider, it is easily understood and universal in application. It involves merely the payment of the normal surface fare to BARTD and the receiving of a transfer which is good for the return surface leg when validated in the BARTD station. For a surface round-trip originating from a BARTD station, it involves the purchase of a round-trip two-part ticket or a surface transfer which in turn would be good for a return free trip on the surface leg—in either event involving the full payment of the surface fare in the BARTD station.

For a three-vehicle ride, Plan C would be similar to Plans A or B. It would involve the use of a transfer for the second Muni leg or the second AC Transit leg in the same one-way journey. This could be accomplished with the validation plan described above, or by use of a special transfer which would have detachable coupons good for successive rides and with such validation as would be required for purposes of control.

The accounting task under Plan C would be straightforward. The surface carriers would have all of the moneys and a record of surface feeder legs for all surface round trips originating on the surface carriers. The validated transfers accepted for surface rides would determine the volume of such riding. For the surface round trips originating from the BARTD stations, the complete record of the transaction would be available in the ticket or transfer vending machine and the money for these trips would all be deposited in the vending machines.

Disadvantages of Collection Plan C

This plan does not permit the discounting of fares for the 2%-5% of the surface riders who will be using service transportation to or from BARTD on a one-way basis.

A second disadvantage is that Plan C requires the passenger to carry with him a transfer or return ticket of some type which will be used on the surface feeder leg on his return trip.

Conclusion with Respect to Collection Plan C

Unless the three transit systems involved should decide that *every* joint passenger must be granted the opportunity for a discount on a one-way basis, some variation of Plan C would appear to be the best system. Plan C does not permit a one-way discount. This defect, however, would apply to only 2%-5% of the surface riders on the Muni and AC Transit systems, as projected for 1975.

Plan C is easily understood by the passengers and easily administered by the transit systems. The task of carrying throughout the day a return trip ticket or heavy paper stock transfer for the surface lines' return journey does not seem burdensome. It is certainly no more of a burden on the patron than carrying the BARTD stored-trip ticket which will be used by a large number of BARTD passengers. The purpose of carrying the return ticket or transfer is to permit the passenger to buy a surface round trip with one cash transaction.

Plan C, of course, is not as simple as Plan B. However, Plan C does not have the defect of unbalanced fares in two directions, and therefore would not result in an imbalance of riding on both the BARTD and surface systems. This deficiency in Plan B may, in our judgment, be adequate to require a search for alternatives. Plan C seems to be the most logical alternative. It divorces the fare collection on BARTD from that on the surface systems. It is easily understood, easily collected. The accounting tasks can be adequately accomplished.

In conclusion, it should be pointed out that final recommendations on a collection procedure for joint fares will depend to some degree upon BARTD's choice of its system of fare collection; associated problems which influence the selection of a system of handling these transfer passengers are dependent upon policy and operational decisions to be made by the operating agencies.

The three alternatives reviewed herein—Plans A, B and C—represent the range of choice under the criteria of a fully mechanized fare collection system on BARTD and a system which requires no additional fare collection equipment on surface vehicles. If it should be decided that every passenger must be accorded a discount fare for a one-way joint ride, it would appear that some variation of Plan A will be required. If however, it is decided that a far simpler plan which will take into account the needs of 95% to 98% of the surface passengers would suffice, then some variation of Plan C appears to be preferable.

CHAPTER 15

Summary of Transit Recommendations for 1975

THE TECHNIQUES in analyzing various elements of transit operations in the Bay Area, as well as alternatives considered, testing procedures and recommendations—including the support therefor—have been developed in prior chapters. What remains is to draw these recommendations together into a composite picture of transit in the Bay Area in 1975.

The BARTD alignment and facilities are fixed—a three-prong network in the East Bay converging to a transbay link which extends diagonally across San Francisco—forming the interregional backbone of the system. 33 stations—eight on the San Francisco side and the balance spread along the Richmond, Concord and Fremont legs—provide connections with the two surface transit operations, Muni and AC Transit.

MUNI ROUTE CONFIGURATIONS

The recommended Muni system is a fan-shaped feeder-trunk layout of surface and rapid transit routes converging upon the San Francisco CBD as a hub. In addition to the BARTD Mission line, three rapid transit trunk lines are recommended:

- Richmond Rapid—A subway under Post Street and Geary Boulevard from Market and Montgomery Streets to 45th Avenue;
- Sunset Rapid—An extension of the Market Street Subway, branching west at Duboce Avenue through the Sunset Tunnel and beyond to 19th Avenue;
- Twin Peaks Rapid—An extension of the Market Street Subway through the Twin Peaks Tunnel, continuing under St. Francis Circle south along 19th Avenue to San Francisco State College.

The majority of existing surface routes would be modified to accommodate these rapid transit legs as follows:

Streetcar Routes—The five streetcar routes would be converted to bus in addition to:

Route	
J	No change except enlarge southern loop via 30th and Castro Streets.
K	Terminate at St. Francis Circle rapid transit station on the west and extend to BARTD Balboa Park Station on the east.
L	Terminate at West Portal rapid transit station.
M	Terminate at West Portal rapid transit station on the west and extend to BARTD Balboa Park Station on the east.
N	Terminate at 19th Avenue Station of the Sunset Rapid.

Cable Car Routes

59	Extend on the north to Taylor and Beach Streets.
60	No change.
61	Extend at the eastern end via Market Street to proposed Embarcadero Plaza.

Bus and Trolley Coach Routes

1	Shorten on the western end to terminate at Arguello Station of the Richmond Rapid.
3	No change.
2	Eliminate.
5	Convert to bus operation and reroute western end via Arguello Boulevard, California Street, 32nd Avenue and Cabrillo Street to a terminal at LaPlaya and Balboa Streets.

6	Convert to bus operation and reroute to 9th Avenue Station of the Sunset Rapid; continue to Market and Beale Streets and extend to Treasure Island via the Embarcadero Freeway and Bay Bridge.
7	Eliminate.
8	Eliminate.
9	Eliminate.
10	Modify on north end to serve Park Presidio Station of Richmond Rapid and the BARTD Glen Park Station; extend eastern end to 3rd Street.
11	Eliminate.
12	Eliminate.
14	Convert to bus operation with no change in present routing. Short-turn service via Courtland Avenue to Bayshore Boulevard and also via Goethe, Rhine and Flournoy Streets.
15	No change except eliminate Navy Yard leg.
16X	Eliminate.
17	Shorten to terminate at San Francisco State College Station of Twin Peaks Rapid.
17X	Eliminate.
18	Eliminate northbound loop via 45th Avenue and extend northern terminal to 45th Avenue Station of Richmond Rapid.
19	No change.
21	Convert to bus operation and shorten the western end to terminate at Arguello Station of Richmond Rapid.
22	No change.
23	Reroute northern end via Folsom and 25th Streets to BARTD 24th Street Station.
24	Extend southern end via 24th and Evans Streets to Navy Yard.
25	Reroute south of Market Street and extend north of Market Street to replace Route 80.
26	Shorten to operate between the BARTD Balboa Park Station and Van Ness Station of Twin Peaks Rapid via San Jose Avenue and Guerrero Street.
27	Eliminate.
28	Reroute to serve BARTD Balboa Park Station.
29	Shorten north end to terminate at San Bruno and Wilde Avenues.
30	Shorten loop in Marina corridor via Broderick, Francisco and Divisadero Streets.
30X	Shorten southern end to terminate at Geneva and Santos Streets.
31	Reroute via Cabrillo Street and 33rd Avenue to Richmond Rapid Station.
32	No change.
33	Eliminate.
34	No change.
35	Reroute to serve the area east of Twin Peaks and Diamond Heights, connect with Church Street Station of the Twin Peaks Rapid.
36	No change.
37	Extend on the east via 18th Street to BARTD 16th Street Station and Castro Street Station of Twin Peaks Rapid and reroute in Twin Peaks area.
38	Modify western end to serve the 33rd Avenue Station of the Richmond Rapid. Eliminate limited stop and express service.
39	No change.
40	No change.
41	Shorten southern end to terminate at Beale and Howard Streets.
42	Eliminate Davis Street loop; reroute to Navy Yard via Palou Street.
43	Reroute north end to serve Masonic Avenue Station of Richmond Rapid.
45	No change.
47	No change.
51	Extend on west to BARTD Glen Park Station and Forest Hill Station of Twin Peaks Rapid.
52	Eliminate.
53	Extend on western end to BARTD 16th Street Station.
55	Shorten on the western end to terminate at Masonic Avenue Station of Twin Peaks Rapid.
66	Shorten to terminate at 9th Avenue Station of Sunset Rapid.
71	Reroute western end to 19th Avenue and 9th Avenue Stations of the Sunset Rapid.

72	Modify western end to serve 9th Avenue Station of the Sunset Rapid; reroute via Parnassus Avenue and Haight Street to the CBD.
80	Eliminate.
81	Extend western end to BARTD Glen Park Station.
85	No change.
86	Eliminate.

In addition to these changes of existing operations, three new routes would be added in San Francisco:

15X	New express service from the Bayview corridor via the James Lick Freeway to the CBD.
41X	New express service from the Marina corridor via the Broadway Tunnel and existing route to the BARTD 24th Street Station.
82	New crosstown route between the Bayview and Mission corridors serving the BARTD Balboa Park Station.

In northern San Mateo County, the existing local route system would also be modified to provide connection with the BARTD Daly City Station.

AC TRANSIT ROUTE CONFIGURATIONS

The recommended plan for AC Transit operations for 1975 consists primarily of changes flowing from superimposition of BARTD upon that system.

Transbay Routes

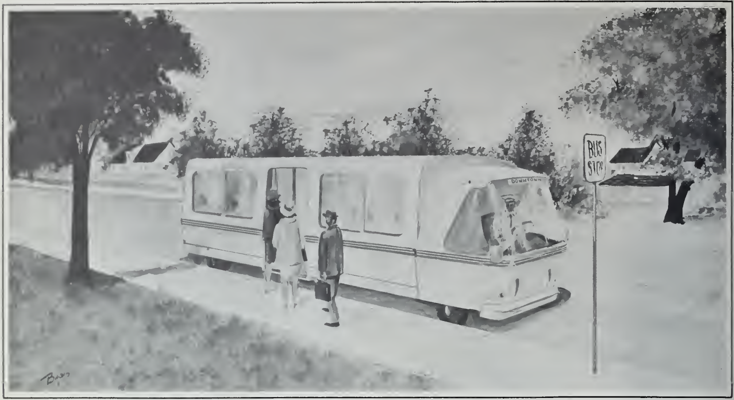
A	Shorten to local feeder service to BARTD 19th Street Station.
B	Reroute to connect with BARTD 19th Street Station.
C	Modify to local feeder service to BARTD MacArthur Station. The CBX and CHS legs would continue in transbay service.
E	Modify to local service route serving BARTD Rockridge Station and via Adeline Street to Oakland West Station.
F	Shorten to local service route to BARTD Berkeley and Ashby Stations and terminate at 45th Street and San Pablo Avenue.
G	Eliminate.
H	Eliminate.
K-R-S	Eliminate.
L	Eliminate.
N-V	No change.
O-W	No change.
T	Modify to operate between BARTD MacArthur Station and Treasure Island.

East Bay Express Routes

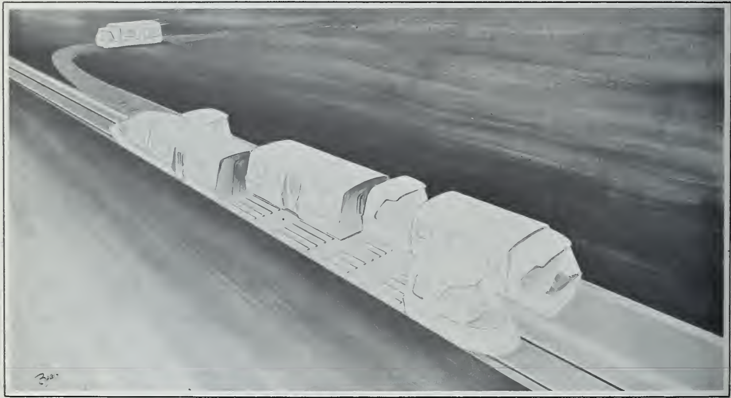
30-32	Eliminate.
31	Eliminate.
33	Eliminate.
34	No change.
36	Eliminate.
38	No change.

East Bay Arterial Routes

11	No change.
12	No change.
14	Reroute to BARTD Lake Merritt Station and northern end to Oakland West Station.
15	No change.
18	No change.
40-43	No change.
42	No change.
51-58	Extend southern end via High Street to the BARTD Fruitvale Station.
59-76	No change.
72	Reroute northern end to BARTD Richmond and El Cerrito del Norte Stations. Reroute in Oakland CBD to BARTD 12th and 19th Streets Stations.
80	Extend southern end to BARTD Hayward Station and reroute from E. 14th Street to BARTD San Leandro Station.
81	Shorten to feeder route via E. 14th Street between the BARTD Hayward and San Leandro Stations.
82	Extend southern end to Fairway Park and reroute from E. 14th Street to connect with the BARTD San Leandro Station.
83	No change.
83A	Shorten to terminate at Hegenberger loop.
83B	No change.
88	Extend on the north to BARTD North Berkeley Station and reroute in Oakland CBD to serve the BARTD 12th Street Station.



LOCAL SERVICE ADAPTATION



BUS-RAIL TRANSFER

FIGURE 46

MODULAR CONCEPT OF LOCAL-TRUNK TRANSFER PROVIDING SINGLE-VEHICLE SERVICE FROM RESIDENTIAL AREAS TO DOWNTOWN SAN FRANCISCO

Feeder Routes

7	Reroute in Berkeley CBD to connect with BARTD Berkeley Station.
17	Modify to serve the BARTD Ashby Station.
46	Extend via E. 14th Street to BARTD Fruitvale Station.
53	Extend on western end from E. 14th Street to BARTD Fruitvale Station.
54	Extend western end via E. 14th Street to BARTD Fruitvale Station; extend eastern end to Mountain Boulevard and Knoll Avenue.
55	No change.
56	Extend northern end via San Leandro Street to the BARTD Fruitvale Station and southern end via San Leandro Street to the BARTD Coliseum Station.
63	No change.
65	Eliminate.
67	Reroute in Berkeley CBD to BARTD Berkeley Station and extend one leg west to Dwight Way and Channing Way and the other east to Dwight Way and Warring Street.
68	Extend in El Cerrito to connect with BARTD El Cerrito del Norte Station and reroute in Richmond to serve BARTD Richmond Station.
69	Reroute in Richmond to serve BARTD Station and extend via San Pablo Avenue to BARTD El Cerrito del Norte Station.
70	Extend via San Pablo Avenue to BARTD El Cerrito del Norte Station.
74	Modify to connect with the BARTD Ashby Station.
78	Reroute in Richmond to serve BARTD Station and in El Cerrito to serve BARTD El Cerrito del Norte and El Cerrito Plaza Stations.
87	Extend to BARTD Fruitvale Station via Foot Hill Boulevard, High Street and E. 14th Street.
90-92	Modify to connect with BARTD Hayward Station.
91	Modify to serve BARTD Hayward and South Hayward Stations.
93	Modify to serve BARTD Bay Fair Station.

Crosstown Routes

57	Extend in East Oakland via Hegenberger Road to the Oakland International Airport and extend in Emeryville to Ashby and San Pablo Avenues.
64	No change.
79	Eliminate Bay Farm Island leg and extend eastern end via High Street to BARTD Fruitvale Station.

In addition to the foregoing routes, it is recommended that the following new feeder lines outside of the service territories of AC Transit be added to service BARTD:

New Feeder Routes in Eastern
Contra Costa County

C-1	Service to BARTD Orinda Station from the residential areas to the south.
C-2	Service to BARTD Orinda Station from the residential areas to the southeast.
C-3	Service from St. Mary's College and the residential areas in between to BARTD Lafayette Station.
C-4	Service between the residential areas of Walnut Creek and Danville and BARTD Walnut Creek Station.
C-5	Service to BARTD Walnut Creek and Pleasant Hill Stations from the residential and commercial areas of those communities.
C-6	Service to BARTD Pleasant Hill Station from the residential areas to the east.
C-7	Service to BARTD Pleasant Hill Station from the residential areas to the north.
C-8	Service to BARTD Concord Station from the residential and commercial areas in the western part of Concord.
C-9	Service between BARTD Concord Station and the residential areas to the north.
C-10	Service between the residential areas to the southeast and BARTD Concord Station.

C-11	Service to BARTD Concord Station from the residential areas to the south.

New Feeder Routes in Southern Alameda County

F-1	Service along Mission Boulevard between the BARTD South Hayward and Union City Stations.
F-2	Service between BARTD Union City Station and the northern residential sections of Fremont.
F-3	Service between the residential and commercial areas of Newark and the BARTD Union City Station.
F-4	Service between BARTD Fremont Station and the residential and commercial areas of central Fremont.
F-5	Service between BARTD Fremont Station and the Niles residential area to the northeast.
F-6	Service between the eastern residential areas of Fremont and BARTD Fremont Station.
F-7	Service between BARTD Fremont Station and the commercial and residential areas of Fremont to the south.

STAGING OF ROUTE CHANGES

An important consideration in properly coordinating changes in existing surface transit systems with new rapid transit lines is the time at which the changes should take place. On the East Bay, modifications in AC Transit routes must be geared with the various stages of BARTD operation; in San Francisco, Muni route changes must be timed with BARTD operations and development of the three phases of the Muni Rapid system. In addition, a new feeder bus service in areas served by rapid transit where there is no existing local transit, or such local service as exists is inadequate, should be planned to coincide with rapid transit operation.

Without relating them to points in time, the stages according to present BARTD operational plans may be listed as follows:

Stage I—The first section of BARTD to be operational will be between MacArthur Station in North Oakland and South Hayward. This section will traverse the southern part of the AC Transit service territory.

Stage II—Transbay service between eastern Contra Costa County, Oakland and San Francisco and service in San Francisco to Daly City make up the second stage of BARTD operations.

Stage III—The third stage will see BARTD operation between Richmond and MacArthur Station in the northern part of AC Transit service area.

Stage IV—The last stage of BARTD operation in the East Bay to be available will be the line between South Hayward and Fremont.

East Bay Route Changes

The first stage of BARTD operations will require changes in AC Transit routes in the area between Oakland and Hayward. Transbay routes will continue to operate, but express routes competing with BARTD would be eliminated. Arterial and crosstown routes would be modified to the appropriate stage of BARTD operations.

The impact of the second stage of BARTD operations will be on the transbay routes except those serving the northern part of AC Transit territory. The change from transbay to feeder routes proposed for Routes A, C and E would be made concurrent with BARTD transbay operation and Route K-R-S serving the southern part of the AC Transit territory would be eliminated.

This stage would also see the inauguration of new feeder routes in eastern Contra Costa County in areas not served by AC Transit.

With the beginning of the third stage of BARTD operations—from MacArthur station in North Oakland to Richmond—the remaining changes in AC Transit routing would take place. Transbay Routes G, H and L would be eliminated along with express Routes 31 and 33. Transbay Route F would be converted to a local feeder route. Twelve arterial crosstown and feeder routes would be modified to feed BARTD.

The fourth stage of BARTD operations—South Hayward to Fremont—will result in the start of new feeder routes in the Fremont-Newark-Union City area of southern Alameda County outside of the AC Transit service district.

San Francisco Rapid Transit Stages

In San Francisco, the proposed route changes are designed to coincide with the beginning of

BARTD operation to Daly City, construction of the Twin Peaks line and development of the Sunset and Richmond rapid transit lines. In addition, other route changes have been proposed that are not directly related to rapid transit; these can be made effective at any time operating conditions permit. Five stages are envisioned as follows:

Stage I—Involves changes in existing Muni routing which do not result from rapid transit development.

Stage II—Route changes resulting from opening of BARTD through San Francisco to Daly City.

Stage III—Upgrading the Twin Peaks rail lines to full rapid transit between San Francisco State College and the CBD would involve the third stage of route changes.

Stage IV—Opening the Sunset rapid transit lines between the Sunset residential area and the CBD.

Stage V—Grade-separated rapid transit in the Richmond corridor would be the fifth stage of the proposed Muni system.

Muni Route Changes

Several route changes in the Muni system are not related to rapid transit operations and can be made as soon as operational conditions permit. Eighteen route modifications and the introduction of new express routes in the Marina and Bayview corridors are in this first category (see Appendix D).

Concurrent with the second stage—BARTD operation to Daly City—19 existing routes would be changed. Eight routes in the Mission corridor would be eliminated and the remainder modified to feed BARTD stations. One new route—No. 82—would replace Route 52 which would be eliminated.

With the opening of the Twin Peaks rapid transit line the existing streetcar lines—K, L and M would be modified to become rapid transit feeders. In addition, Route 17 in the Parkmerced area would be shortened and Route 17X—an express route from Parkmerced—would be abandoned.

The fourth stage of route changes would result from the opening of the Sunset rapid transit line. Six routes, including the N streetcar line, would be modified as part of this stage and Route 16X would be abandoned.

With rapid transit service in the Richmond corridor, eight route changes and one elimination would take place. These changes would complete the fifth stage.

INTERIOR BARTD RAPID TRANSIT CAR

Some routes, such as Nos. 18, 37 and 51 are scheduled for changes in more than one stage.

Trolley Coach Conversion—A separate, but important consideration when Muni route changes are made is the conversion of certain trolley coach routes to bus operation. The Muni modernization program calls for the conversion of Routes 5, 6, 14 and 21. Routes 7, 8, 9, 12 and 33 are to be abandoned. None of these routes is scheduled for change before the second stage and only Route 14 would be changed in that stage. However, from the standpoint of construction economies and as part of the Market Street rehabilitation program, these lines should be converted to motor bus, prior to Stage II.

FLEET REQUIREMENTS

Muni fleet requirements for 1975, including spares, aggregate 706 vehicles, as follows:

Rapid Transit Cars—115
Motor Coaches—450
Trolley Coaches—110
Cable Cars—31

This would be a reduction of 28% in size of the present fleet, substituting vehicles of greater capacity, speed and utility.

The AC Transit system will remain an all-bus operation with reduced needs of 500 coaches in 1975.

SHOP AND GARAGE FACILITIES

Shop and garage facilities in San Francisco require modifications independent of route changes; those on the East Bay need changes to accommodate the expanded feeder service function of the AC Transit operation.

Recommended improvements in Muni maintenance facilities include:

- Kirkland Division—New garage and office facilities;
- Ocean Division—New two-level storage and service facilities;
- Potrero Division—Convert existing trolley coach structure to motor coach service operation;
- Presidio Division—Improve existing trolley coach service accommodations and modernize Muni general offices;
- Automotive Overhaul Shop—New two-story structure with improved accommodations for motor overhaul, body and paint shops, storeroom and offices;
- Rail Service Facility—An underground installation with storage yard, servicing, repair and overhaul facilities, and shop offices adjacent to Twin Peaks Subway for maintenance of rapid transit equipment.

The changes recommended in shops and garages of AC Transit include:

- Division #2 Garage—Extension of existing maintenance building and construction of additional building to accommodate welding shop, storage of upholstery, tires, etc.;
- Division #3 Garage—Reduce existing facilities to satellite depot with minimum dispatching and storage accommodations;
- Division #4 Garage—No significant changes.

OTHER MUNI CAPITAL FACILITIES

The general deterioration of Muni plant and facilities makes necessary the inclusion of other capital items in this recommended plan.

Cable Car System—The two foregoing route extensions on cable car lines and the importance of cable cars in San Francisco's overall image require:

- Improvements to way, structures and equipment including partial rerailing, alarms, signals and braking systems for increased safety and efficiency;
- Restoration of cable car barn including a visitors' gallery, museum, and displays to enhance its historical value.

Power System—Power requirements for Muni operations will change substantially by reason of proposed reduction of trolley coach lines, elimination of streetcars and addition of three new rapid transit trunk lines. Several existing substations will be abandoned. Five new substations will be needed for the Richmond Rapid, and two additional for Sunset Rapid. Existing Twin Peaks substations will be upgraded with solid state rectifier equipment to accommodate the Twin Peaks Rapid.

Special Facilities—Additional facilities recommended for operating efficiency and passenger accommodation on Muni include:

- Radio-telemetry Control—A two-way radio system for communicating with rapid transit and surface vehicles;
- Park-ride—An underground garage at Park Presidio to intercept Marina motorists and switch them to the Richmond Rapid;
- Minibus—Side-loading Minibuses for short downtown routes;
- Speedwalks—Electric walkways for passenger distribution at Market Street Rapid stations;
- Traffic Priorities—Bus-actuated traffic signals on arterial routes, no-parking restrictions, lengthened bus stops and other priorities for speeding transit service;
- Bus Shelters—Attractive shelters with telephone information hookup at heavy street-loading points.

RECOMMENDED FARE STRUCTURES

The following fare structures for each of the three Bay Area systems and for combinations among them are recommended as offering the optimum balance between revenue production to support operations and attractiveness in luring passengers to the system:

BARTD Fares—A range of station-to-station adult fares, between 25¢ and $1.00, according to the following formula:

First 4 miles	25¢
4 to 10 miles	25¢+ 4¢/mile
10 to 15 miles	50¢+ 3¢/mile
Over 15 miles	65¢+ 2¢/mile
Maximum Fare	$1.00
Transbay	50¢ minimum; 4 mile premium on above rates
Peninsula	25¢ within San Francisco
Maximum Fare on Peninsula	35¢
Multiple-ride Tickets	11 rides for the price of 10, applicable to cash fares above 50¢
Sunday-holiday Pass	75¢ for unlimited rides on Peninsula
Sunday-holiday Pass	$1.00 for unlimited rides on East Bay lines
Students and Children	60% of adult fares
Station Parking	25¢ all-day at BARTD stations

AC Transit Fares—Recommended fares for the modified AC Transit system include the following:

Adult Single Zone Cash Fare	25¢
Multiple Zone Increments	Same as present[1]
Transfers	Free
Transbay Fares	
Cash	50¢
Multiple-ride Ticket	20 rides for $9.00[2]
Surface Feeder to BARTD	25¢/Round Trip
Students and Children	15¢
Sunday-holiday Pass	75¢ for unlimited rides in the East Bay area

Muni Fares—It is recommended further that fares on Muni be brought up to the level of the other two Bay Area transit systems as follows:

Adult Surface Fares	25¢
Surface Transfers	Free
Adult Muni Rapid Fare	25¢
Adult Combination Surface-Muni Rapid Fare	30¢
Surface Feeder to BARTD	25¢/Round Trip
Students and Children	15¢
Sunday-holiday Pass	75¢ for unlimited rides over entire system
Multiple-ride Tickets	None

Combination Fares—Under the foregoing recommendations for the two surface systems, feeder trips to BARTD are included at 25¢ for the round trip. The combination fare, therefore, would be full BARTD fare plus 12½¢ for the feeder bus ride to or from BARTD, or both. The 12½¢ discount should be shared between BARTD and the two surface systems in accordance with a discounting formula to be resolved among them.

FARE COLLECTION

Discounts for combination rides will be offered only to round-trip patrons under the recommended fare plans. A passenger using a surface transit vehicle to reach BARTD will obtain a BARTD-return ticket upon paying his surface line fare. This ticket will be good for a return ride on the surface line without charge after validation within the BARTD station.

The passenger originating on BARTD will purchase a similar ticket for 25¢ within a BARTD station, then use the ticket for the outbound trip to complete his journey. The return portion of that ticket will enable him to make a free return trip to that station.

A passenger making a Muni-BARTD-Muni or AC-BARTD-AC journey will follow the pattern outlined above for a passenger beginning his trip on a surface vehicle, utilizing the same procedures and privileges.

PROJECTED RESULTS OF OPERATIONS IN 1975

A thumbnail picture of projected results of this recommended transit plan for the three Bay Area transit systems compared with actual results in 1965 is summarized in Table 75.

The overall gain in revenue passengers is 67%, to a volume of well over a million riders daily. The actual rise projected for this decade is overstated by this comparison for a couple of reasons:

(1) A passenger making a two-system journey on Muni and AC Transit is reported as two revenue passengers in both periods; the proportion of this will be significantly greater in 1975 since 65% of BARTD riders will reach the system by Muni or AC Transit;

(2) On three-vehicle journeys with rapid transit as the middle leg (either BARTD or Muni Rapid), the 1975 figures include this as three revenue passengers. No similar trips were made in 1965;

(3) Greyhound traffic is not reported in either the 1965 or 1975 totals on Table 75. BARTD, however, will absorb the Greyhound movement from Eastern Contra Costa County.

Making allowances for these dissimilarities, the expected gain in transit riding will be closer to 30%, which is still an impressive increase for this ten-year period.

Passenger revenue is expected to rise 120%—one of the fastest growth expectations among major industries or services in the Bay Area. This will be the product of two items—more transit traffic and higher fares.

BARTD will be the principal addition, both in revenue and passengers carried. It is significant that both Muni and AC Transit will also show higher total passenger volumes in 1975 than in 1965, due to their tributary services to BARTD.

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[1] See table entitled "Adult Fares—AC Transit Local Lines," Chapter 5.

[2] For the cost of multiple-ride tickets on journeys beyond the central zone, see table entitled "Adult Fares—AC Transbay Lines," Chapter 5.

Operating costs are projected to rise 75%, from $43 million to $74 million.

Deficit operations will continue at Muni and AC Transit. It is noteworthy, however, that the three systems in combination are projected to be much closer to the break-even point in 1975 than the two existing operations, Muni and AC Transit, have been in recent years.

Table 75

PROJECTED 1975 RESULTS OF OPERATIONS
Three Bay Area Transit Systems

	1965	1975	Percent Change
Revenue Passengers			
BARTD	-	56,552,832	-
Muni	141,724,908	208,496,845	+ 47.1%
AC Transit	52,905,464	60,414,714	+ 14.2
Systems Total	194,630,372	325,464,391	+ 67.2%
Passenger, Charter and Advertising Revenues			
BARTD	-	$ 25,723,433	-
Muni	$ 19,820,932	35,605,660	+ 79.6%
AC Transit	13,268,079	11,407,791	- 14.0
Systems Total	$ 33,089,011	$ 72,736,884	+119.8%
Cost of Operations			
BARTD	-	$ 13,596,360	-
Muni	$ 27,966,377	43,525,177	+ 55.6%
AC Transit	14,827,112	17,055,659	+ 15.0
Systems Total	$ 42,793,489	$ 74,177,196	+ 73.3%
Net Revenues			
BARTD	-	$ 10,589,016	-
Muni	$ -7,991,711	-6,947,080	+ 13.1%
AC Transit	-1,463,421	-5,082,248	-247.3
Systems Total	$ -9,455,132	$ -1,440,312	+ 84.8%

CHAPTER 16

Promotion of Transit Service

EFFECTIVE PROMOTION of transportation services may be conceived as a strategy for integrating the marketing elements of surface and rapid transit systems in the Bay Area:

- *Traffic Analysis*—Continuing research to identify and expand that share of the Bay Area travel market which mass transportation can serve effectively;
- *Service Standards*—Developing the quality items of transit service, i.e., type and style of vehicles, travel speed, standee policy, service frequency, on-time performance, accommodation service, etc.;
- *Fare Policy*—Assessing the share of system costs to be borne by fares, price formulas for distance traveled, class of service, etc., and discount policies for children, students, senior citizens, multiple-ticket purchase, combination rides, etc.;
- *Communications*—The informational services to properly acquaint all beneficiaries—employees, passengers, property owners and general public—with the transportation system, its service standards and fare policies, as well as its role in fulfilling community goals of mobility.

Heretofore, promotion has been thought of in the narrower sense of the fourth item, only—the informational or bulletin services. Such promotion as has been undertaken by transit companies has been meager and quite conventional—distribution of timetables, traditional press releases, limited newspaper ads announcing a new route or charter services, etc.

But it is evident that the substance of informational services is generated within the service and fare policies for the transportation system which management seeks to impress upon the travel market. Since these elements of marketing are interacting, it is appropriate to consider them as an integrated group rather than separate and remotely related policy determinations.

Before considering guidelines for promotion of transportation services in the Bay Area and the means of implementing them, it may be well to review two fundamental questions: first, what community objectives or goals are sought in developing the Bay Area transportation network? Secondly, what groups benefit from an improved transit system, directly or indirectly, and how may their interests be enhanced?

Transit Objectives

With a privately owned transit system, it is easy to define the company's objective: to handle as much of the area travel market as falls within limits of financial feasibility. While cost-revenue considerations are important among publicly owned transit systems in the Bay Area, it is significant that none of them is completely self-liquidating, nor are they projected to be in this Project. Both of the two surface systems will continue with moderate supplements from tax revenues, as they have been operating in recent years; BARTD is planned to be self-liquidating only with respect to operating costs and rolling stock. Individually and separately, the communities on both sides of the Bay have arrived at a policy of providing more generous transit service than fares will sustain, in order to fulfill broader goals of mobility and community development.

Other objectives for improved transit have been articulated. Mayor Shelley's aim is a system which will bring every San Franciscan downtown within 20 minutes. Relief from traffic congestion is a frequently-cited goal for rapid transit expansion. Some advocates sponsor transit out of disenchantment with costly and divisive freeways which disrupt neighborhood amenities in established urban areas or with off-street parking structures which preempt valuable space in downtown cores. The tax erosion developing from space demands of auto travel—moving and storage—is a strong influence with public officials to accept transit subsidies as a less costly drain on public funds.

Urban planners see transit as a prospective control device for regulating the physical and social problems of slum and blighted areas. Suburban developers are more interested in the influence of rapid transit on outlying real estate values. It remains to be seen how much of these multi-purpose goals can be satisfied. About all that can be stated with assurance now is that 61% of the residents in three Bay Area counties have voted to underwrite a billion dollar risk on transit in these several directions.

Prevailing differences between San Francisco and East Bay communities indicate some variation in thinking on the function of transit. San Francisco is a mature city with developed residential sections and well-established activities, interests and institutions—all resistant to change. In this entrenched complex of economic, social and political forces, Muni is bargain-basement transit. It has low fares and frequent service, but its vehicles and physical plant have been badly neglected. Muni simply lacks quality. Apparently, some citizens condone this; not a majority, but enough to withhold the two-thirds plurality needed for overdue capital improvements. This is unfortunate, for the opportunity exists here—better than in any other American city—for transit to provide an outstanding service.

East Bay communities, on the other hand, are suburban in economic and demographic outlook. They have grown at an accelerating pace over the past two decades and foresee a continuing rise in population and economic expansion to 2000. The primary objective here is to maintain orderly control of the growth forces and anticipate future needs. In this climate, AC Transit has done an outstanding job of converting an atrophying bus operation into an active force for community development. With limited resources, it has expanded its routes, increased service, bought new buses, extended transfer privileges, and actively and aggressively told its story to patrons and motorists alike in its territory.

BARTD will be a different transit service on the two sides of the Bay, just as the attitudes and aspirations of these communities are different. In San Francisco, it will be a fast trunkline to downtown; in Berkeley and Oakland, an alternate to traffic congestion on the Bay Bridge into San Francisco, and in Fremont and Concord, a realty catalyst. Nationally, BARTD is a billion dollar experiment to determine whether the highest and best application of transit facilities can lure commuters out of automobiles.

Between the two present systems, public transportation now is being operated or developed under varying restraints with little relation to one another and only incidental consideration of their collateral effects upon each other or upon future community development. A reasonable degree of working cooperation prevails. But there is need for a higher order of coordination; the need persists for an orderly and economical program of urban transportation development—a system analysis that will not only provide an accurate prospective of needs and solutions, but one which will promote public acceptance of improvement programs. This objective is one of the primary aims of this NCTDP program.

In summary, the transportation objectives for the Bay Area may be consolidated to embrace these influences:

- Attraction of a major share of peak-hour traffic to and from the San Francisco and Oakland business districts to relieve rush-hour traffic congestion on Bay bridges and other congested arteries;
- Reduction of all-day parking demands in business areas to provide more space for shoppers and other optional auto travelers in high-density areas;
- Mobility of pedestrian circulation in the business, shopping and civic centers of San Francisco, as well as the high-density core areas of other Bay Area cities;
- Promotion of population growth in suburban residential sections;
- Controlled development of land use activities—residential, commercial, industrial and recreational—in accordance with local community desires; and
- Renewal and redevelopment of blighted areas.

Policy considerations will determine for each transportation system the relative importance of these objectives, their significance in the pattern of local and regional growth, their impact upon cost-revenue relationships in determining transportation service standards and other parameters for assessing the effectiveness of the regional transportation network. The purpose now in defining objectives is to point up the need for more sophisticated measures of the transportation system's worth than a dollars-and-cents tabulation of passenger revenues and operating costs.

Groups Influenced by Transit

Eight out of every ten transit patrons in 1975 will be required either to travel a different route, or ride a different vehicle, in order to make the same journey as in 1965. This is the substance of the route changes and traffic projections for the 1965-1975 decade developed under this Project.

It is evident that a massive task of re-educating the transit-riding public will be required just to preserve the present share of the market. Experience in developing route patronage reveals that deep and repeated penetration of basic route information among potential users is required to impress a significant share of those who can use a transit service. Where established transit routes are disturbed significantly, such as re-routing due to introduction of a one-way street pattern, transit patronage declines 15-20%. This is due to the disruption in riding habits among patrons and their unwillingness to trace out the coach route changes.

Since this involves the present body of transit riders, the first efforts in promoting use of an improved transit service in the Bay Area should be to make certain that this group understands fully and is sold thoroughly on the merits of proposed changes. Next, existing tripmakers between origins and destinations where the travel time ratio by transit will be significantly improved should be acquainted fully with the new service and its possibilities for them. A campaign of selective intensity directed at those movements among the 474 Bay Area travel analysis zones offering the most favorable opportunities for exploitation needs to be developed. And, thirdly, a program of detailed transit information for new residents in developing suburban areas, keyed to their likely places of employment, shopping and recreation should be prepared.

This represents the minimum promotional effort needed just to acquaint 1975 potential transit users with the improved service which planners have already assumed will be accepted and regularly used. Beyond this, there is a distinct need for impressing other potential patrons with the desirability of transit use on marginal trips.

The future for transit in the Bay Area need not be permitted to just happen. There is a growing awareness that much can be done about the future in terms of probability, and that, with proper planning, management can exert substantial influence over the probabilities. From these considerations, it would appear that a 'traffic analysis' approach to market identification and promotion, similar to the 'systems analysis' now developing in industry with major reliance upon data processing techniques, should be the approach to a desired passenger response. Already, a substantial foundation of transportation and demographic data has been developed through this study, providing a flexible framework of information on present transit users, factors influencing their travel choice and growth opportunities for population and increased riding. For example, in analyzing the travel time differential between transit and auto from 150 travel zones in San Francisco to downtown, it was pointed out that a five-minute improvement in overall transit service would double the number of zones in which transit has a time advantage over the automobile. From a marketing standpoint, the need is to be able to identify readily those particular zones in

order that full promotional efforts can be directed at their residents to maximize this service advantage.

What is required is systems planning of passenger flow on a current and continuous basis, yielding a sensitive and coherent network of travel information and tripmaker decisions that fit one another. Instead of the old cut-and-try techniques of route layout and service planning, a program emphasizing current information, then forecasting by simulation and finally promotion should be developed for coordinating the separate elements of the overall transportation effort. The capability of predicting the combined effect of several lines of simultaneous action upon one another is the important new ingredient. By simulation techniques, policy makers can evaluate alternatives to reduce unwanted consequences or develop other lines of planned action to compensate for predicted consequences.

In addition to transit patrons to be directly benefited, there are several other groups to which transit promotion should be directed under certain circumstances:

- Transit Supervision—While each system's management is aware of the class of service and territory of other public transit systems within the region, there is need for fuller understanding and recognition of the differences in quality standards, price policies, political restraints and financial limitations which influence effective coordination among them.
- Transit Employees—Coach and train personnel particularly, and other employees to a lesser degree, should be acquainted fully with transit services throughout the Bay Area to provide direct and understandable passenger information.
- Public Officials and Civic Leaders—A close and continuing liaison should be maintained with public officials and community leaders to keep public transportation objectives in tune with the economic and social interests of the people and with current goals for regional development.
- General Public—The dependence of these publicly-owned systems upon a favorable impression with the general public is apparent. In addition to a primary need for public acceptance, there is the further objective of arousing public curiosity to try transit service as a step in expanding the scope and growth of the total transit market.
- Property Owners—This particular segment of the citizenry in the three Bay Area counties has a proprietary interest in transit welfare by reason of the special tax levies for transit development. It is quite natural for them to look for some reports of progress and measures of the systems' effectiveness as a community service.

Guidelines for Coordinated Transportation

Before considering the means of carrying out a coordinated program of transit promotion, it is helpful to develop a framework of guidelines embracing acceptable public policies reflecting the broad and continuing needs of the Bay Area. This framework of public policy would include the following principles:

1. The Bay Area region should be the basis for transportation planning. While San Francisco is the central community, its transportation needs extend well beyond city limits. Both its employment and commercial markets draw heavily upon the four surrounding counties, making necessary a strong public transportation system to the San Francisco business district.
2. Close coordination of schedules, fares, and other service matters among the three transit systems is required. 65% of BARTD's patrons will reach the line by one or both of the surface transit systems. Quite obviously, the degree of transit market expansion will be dependent upon the ease with which surface-BARTD transfers are accommodated.
3. Transit market analysis ought to include a more thorough understanding of auto travel. Consideration should be given to trip restraints—streets and highways, traffic control systems, parking facilities—in relation to local transit systems and inter-connections between auto travel and local transportation. From the community standpoint, it is axiomatic that all modes used through-

PROPOSED TRAIN CONTROL AND COMMUNICATION CENTER FOR BARTD

out the Bay Area are part of a single transportation network.

4. The interrelationship between transportation planning and land activity should be acknowledged. In downtown areas, for example, greater emphasis must be placed upon the economy of both time and space in transportation. Municipal policies should be channeled toward a more effective demand for improved transportation via space-saving modes such as rapid transit, buses, commuter trains and even pedestrian aids such as escalators and speedwalks.
5. 'Cost-effectiveness' analysis should be made the governing basis for significant decisions on metropolitan transportation. A comparative analysis of total costs with total benefits under various alternatives for each undertaking will provide an array of various means and ends so that policy makers will have a more evident choice for measuring results against objectives and expectations. In some instances, the benefits may not be readily determinable; this is often the case with aesthetic qualities —low noise level, freedom from air pollution, open space—for which it is difficult to derive a precise monetary measurement. Nevertheless, some judgment value of these factors in a cost-benefit analysis is better than no estimates at all.

These five principles should serve as a set of guidelines for planning and operating each transit service as a complementary part of the metropolitan transportation system, in keeping with the economic and social interests of the people and with long-range goals for regional development.

TRANSPORTATION SYSTEM ADMINISTRATION

If proper coordination of transportation planning in relation to operating systems, land development, population growth and economic expansion of the metropolitan area is to be accomplished, a forum must be established as a continuing activity to apply the foregoing principles. Each transit system is an administrative unit of a separate government with different duties and responsibilities and quite different financial restraints, determined either by legislative enactment or bond indenture or both; the coordinating agency must fit properly within these policy and financial limitations. A compact is proposed among MUNI, AC Transit and BARTD for a dual purpose:

- To provide a forum for review of existing transportation policies and practices, separately determined by each transit system, which have some interaction with the other two transit agencies;
- To administer the joint promotional efforts which will be handled more effectively on a coordinated basis.

This compact would be a successor to NCTDP and carry forward its organization and study recommendations as a policy program. The activities of the compact might be considered under four headings:

I. *Planning*—The compact would evaluate the soundness of existing transportation policies and practices in the light of guidelines previously outlined.

II. *Programming*—The compact would
   (a) Determine transportation deficiencies and probable future needs, both facilities and operations.
   (b) Prepare feasible plans to improve public transportation service,
   (c) Establish priorities and authorize continuing programming on an analytical basis,
   (d) Inform the public on transit progress and future developments,
   (e) Advise federal, state and local legislative bodies of transit needs and the proper functional relationship between transportation and local government.

III. *Budgeting*—The compact would determine a budget for promotional services to be accomplished jointly, the formula for which would be made a function of joint fare allocation. A portion of joint fares for transit promotion is suggested as a convenient means of allocating such costs and one which will provide reasonable assurance of program continuity.

IV. *Implementation*—The compact would determine which functions can best be accomplished as in-house activities and those to be handled by advertising agencies, consultants, etc. It would provide a candid review of the results of transit development and promotion programs, including a system of keeping track of progress toward interim goals, with a shift in emphasis to changing values and evolving ends where necessary.

Following the initial recommendation of this compact,[1] the three agencies approved a resolution which provides for a liaison committee representing the three agencies for the development of recommendations to the agencies for achieving project objectives and implementing various phases of the coordination program. The agencies further resolved that full use be made of the guidance plans for coordination of local and regional transit facilities so that the potential benefits to be derived from the project are fully realized.

Joint Promotional Services

Joint handling of certain basic information services appears desirable to insure correct and understandable trip information to passengers. More detailed study of present practices on telephone information service, schedule-making practices, timetable preparation and distribution, etc., is needed to determine the exact point at which effective coordination among the three transit agencies can best be accomplished. It may be that the three systems can be trained to coordinate passenger activities while retaining their individuality, the same as airlines handle joint bookings. Or, the three systems could be integrated for certain passenger handling functions, while retaining their corporate individuality, similar to operating units of the Trailways Bus system.

A variety of alternatives is available for automating this joint transit information service. A computer program can be developed to provide quickly desired information concerning the operating characteristics of the three transit systems including routes, schedules, and transfer arrangements.

The transit network developed in the traffic estimation process would provide the basis for areawide computerized information service. This network is a series of links and nodes describing each area in machine language, as well as all of the transit routes in the three-county Bay Area transit system. Some additional programming would be required to accommodate schedule and transfer information.

Under an automated system, a caller seeking route information would state his location and destination to an information clerk who, in turn, would transmit that data to the machine. The latter would then print out routing, departure times, transfer information, fares and other particulars for that trip.

A variation of this program would be to provide special telephones at central locations such as hotels, tourist attractions, etc., along with a coded list of principal attractions in the Bay

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[1] Simpson & Curtin, *Technical Memorandum No. 71: Promotion of Transit Service in the Bay Area*, January, 1967.

Area. The caller would simply dial his desired destination to the central information computer and a printed card would be returned to him showing the proper routing, leaving times, transfer connections and fares.

Other items to be reviewed for such joint administration include:

1. Service Schedules
2. Timetable Preparation
3. Timetable Distribution
4. Other Passenger Information Services
5. Maintenance of Schedules
6. Fare Collection Practices
7. Auditing of Joint Fares
8. Accident Prevention Programs
9. Handling of Complaints
10. Employee Courtesy Programs
11. Tie-in Arrangements with Merchants
12. Special Services Promotion—Football Games, Conventions, Special Party Services, etc.
13. Off-Peak Trip Promotions, including Shopper Specials and Weekend Tours
14. Advertising
15. Tours of Transit Facilities
16. Demonstration Projects with Federal Assistance
17. Reduced Fare Experiments

Aggressive promotion of transit service by coordinated development of these functions is in keeping with the policy declarations of the state and federal governments. "Nothing is so local as local transportation" was an infirmity of the transit industry which both higher levels of government have taken definite steps to overcome. Likewise, the individual transit agencies and local governments within the Bay Area must coordinate their facilities in recognition of the fact that their responsibilites for transportation service are clearly metropolitan in scope. Auto travel is so well integrated that motorists are seldom aware of when they are traveling on state highways, county roads, city streets, or even toll-crossing connections. In a competitive sense, a comprehensive formula for handling joint transit functions among the three operating agencies so that passengers obtain a similar feeling to that enjoyed by motorists is the key to aggressive transit promotion.

Attributes of Good Transportation

In devising an aggressive program of promotion for transportation services, it is important to take into account the several factors influencing modal choice by travelers. Several studies have been made to determine the value of time saving and other factors affecting individual choice of transportation mode. The items most frequently considered in these analyses include:

Cost
Convenience
Travel time
Comfort
Status
Traffic congestion
Parking
Flexibility
Need for auto use
Availability of public transportation
Weather
Speed of operation
Crowdedness
Frequency of service

Studies at the University of Michigan Survey Research Center and Stanford Research Institute reveal that:

- No single variable such as travel time is an accurate predictor of modal choice,
- Transportation decisions by the same individual are likely to vary from time to time as his needs fluctuate,
- Variables influencing transportation modal choice will differ in their importance with the purpose of particular trips,
- Relative cost of alternate modes of travel is a less important determinant than other factors.

A recent study at the University of Maryland on consumer preferences in transportation developed a set of attributes for an ideal transportation system based upon psychological testing. While these findings are preliminary, they are nevertheless revealing as an indication of the targets toward which emphasis might be directed in an overall promotional strategy.

The significant attributes in passenger satisfaction with transportation service are ranked in order of their importance as follows:

1. **Reliability of Destination Achievement**—This factor reflecting both time consideration and safety is the most important to respondents on the "to work" trip, reflecting the need for being at work on time.
2. **Convenience and Comfort**—Waiting in lines and comfort of seats (in that order) were also considered important for the "to work" trip. Degree of crowdedness ranked higher on social-recreation trips and out-of-town trips than for other trip purposes.
3. **Travel Time**—Travel time is important on the work trips, with lesser significance to other trip purposes. For the latter, freedom from repairs, comfort and cost are more important.
4. **Cost**—Variations in response reveal that people are not fully aware of comparative travel costs by alternate modes. Variable costs appear to be the only relevant consideration in auto travel where people already own the vehicle. A significant upward change in costs without change in quality of service is likely to raise the relative importance of this attribute.
5. **Independence of Control**—Certain groups are desirous of maintaining autonomy in determining speed, economy, routes, etc., in trip-making. However, there are indications that this attribute is not as crucial in selection of travel means as it might appear.
6. **Traffic Congestion**—The significance of this attribute is a function of annoyance, lack of safety and travel time in particular instances. The research in Baltimore and Michigan indicates that current preference for automobiles is not likely to be greatly influenced by traffic congestion in the foreseeable future. Quite different attitudes, however, are possible when the major traffic movements are controlled by a single artery such as the Bay Bridge.
7. **Social**—Ability to ride with friends is an important factor in auto travel for social and out-of-town trips, but of little importance for work trips.
8. **Age of Vehicle**—This status factor has some influence among automobile buyers, although it appears that a concern with reliability is a more significant reason for new car purchases.
9. **Diversions**—Diversion items are regarded as least significant, the principal exception being the scenery variable for out-of-town trips.

Measures of Effectiveness

A final consideration in developing an overall promotion program is the development of a proper set of measures or yardsticks to reflect the overall effectiveness of transportation service. As previously indicated, it is not enough just to determine the profitability or cost-revenue relationship for each system, although this is one important measure. A deficiency in this respect may be offset by favorable indications of other transportation barometers. Measures for consideration in this category include:

a. Passengers carried, by route, from each analysis zone
b. Population served
c. Population growth
d. Number of household units
e. Changes in income level
f. Changes in assessed valuation
g. Commercial activity

With respect to the latter measures, the experience in Toronto after 10 years of rapid transit operation reveals that "if the urban rapid transit system never earned a dime, it would pay for itself many times over through its beneficial impact on real estate value and increased assessment. The greatest cities in the world have this essential common facility—an efficient rapid transit complex."[2]

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[2] G. Warren Heenan, "Rapid Transit and Property Value," *Community Planning Review*, XVII, No. 1 (1967), 5.

Appendix A—WORK PROGRAM

The Work Program of the Northern California Transit Demonstration Project was the result of several months' effort on the part of representatives of the three agencies—BARTD, Muni and AC Transit. This prospectus was reviewed by Federal officials and formed the basis of the agreements between NCTDP and its primary contractor and subcontractors.

The Work Program comprised seven items as follows:

WORK ITEM I

TO DEVELOP METHODS AND TECHNIQUES FOR DETERMINING THE FULLEST PRACTICAL DEVELOPMENT OF COORDINATED SERVICES BETWEEN ANY COMBINATION OF RAPID TRANSIT AND LOCAL SURFACE TRANSIT SYSTEMS.

This effort must be accomplished quickly, and must utilize and develop the best techniques for precisely such purposes as are anticipated in this demonstration grant. Such a study must analyze with reasonable accuracy the existing travel characteristics through the application of judicious combinations of synthesized surveys, postcard surveys, cordon surveys, and home interviews. The urgency of this work is necessary since it is to be the foundation on which much of the balance of the demonstration grant will be based, and it must be relatively inexpensive as compared with a comprehensive five-year survey, for example.

A. Travel characteristics of potential transit riders:
  1. Survey of present transit riders
    (a) Origination and destination (rush and non-rush hours).
    (b) Transfers presently required.
  2. Potential new riders
    (a) Development of techniques for making area-wide surveys broad enough to be used as a basis for predicting new rapid and local transit riding.

To develop methods and techniques for determining the fullest practical development of coordinated service between any combination of rapid transit and local service transit systems, it is intended that a mathematical travel survey of the area affected by the three public transportation agencies will be conducted immediately and in sufficient depth to identify the travel between peak and non-peak hours. This survey will be the base upon which much of the project will be constructed. In contrast with the larger, more comprehensive and more time-consuming BATS survey that is under contemplation, this survey will be more intimately directed towards the area now served by public transportation. To accomplish this survey it is intended to engage the services of a qualified consultant or consulting engineering firm familiar with this type of survey. The consultant or consulting engineer will be expected to develop techniques for evaluating the factors that influence public transportation riding. They will be asked to predict the increase in public transportation riding that an effective coordination between the three agencies can be expected to produce. The precise steps to be taken to effectuate the increased riding, i.e., the evaluation of new routes, altering the existing routes, determining the frequency of schedules, etc., will also be a part of the task of the engineering consultant chosen for this work item.

B. Service:
  1. Routes
    (a) Method of evaluating the effectiveness of existing routes and extending, shortening, eliminating or rerouting existing routes.
  2. Determining the need for and feasibility of new routes or services within or outside of existing service areas.
  3. Determining the frequency of service
    (a) Of feeder routes to rapid transit versus through routing.
    (b) On coordination of schedules.

Upon the completion of the accumulation and finalizing of the data developed under "Travel Characteristics of Potential Riders," such information will be used as a guide to determine the service requirements. The most modern techniques and procedures, including utilization of computerized schedules, will be employed in determining the service requirements, including the actual routings and frequency of service to be provided on both trunk line service to be operated independently of rapid transit and on feeder services to be operated in connection with rapid transit. The final determination of the routings and service shall include such areas as are not now currently being served by existing carriers, but shall include the additional area to be served by rapid transit.

WORK ITEM II

DEVELOPMENT OF REQUISITE MODERNIZATION SCHEMES.

A new rapid transit system is a tremendous catalyst for modernizing existing transportation facilities because it affects so vitally so many facets of existing operations—pieces of equipment, types of equipment, maintenance practices, operating procedures, to list but a few. For example, constructing the subway under Market Street will seriously alter or even interrupt the operation of streetcars in San Francisco, every one of which is routed into Market Street. The course to pursue both during and after the subway construction will be a matter of considerable impact on the City of San Francisco. Other important facets of existing operating practices will likewise have rather far-reaching influence and will affect the degree of coordination that is worked out by the transportation systems.

Areas of endeavor are to include:

A. Rolling stock:
  1. Replace
  2. Rehabilitate
  3. Additional
  4. Maintenance and Replacement Program

B. Physical plant:
  1. Replace
  2. Rehabilitate
  3. Relocate
  4. Additional
  5. Joint use of facilities
  6. Station layout and operation in combined and separate systems.

C. Operations:
  1. Development of methods of determining and evaluating the desirability and feasibility of operational changes.
  2. Development of methods of evaluating effects of and desirability of automated operations.
  3. Development of methods of improving communications.

D. Establishment of criteria necessary for the planning of transit systems as an element of a total community plan:
   1. Coordination of transit planning with local planning agencies.
   2. Development of overall long-range transit plan.

As a necessary sequel to Work Item I-B pertaining to service and route changes, the agencies presently serving the area must demonstrate and eventually implement coordination of physical plant, rolling stock, operating procedures, and planning. As an example: existing trolley coach lines should be rerouted to feed rapid transit stations; this leads to the determination of the feasibility of replacing various trolley coach lines with motor coach lines.

The aspect of a requisite modernization for the existing transit systems presents an enticing area of cooperation at an opportune time. It is made necessary by the need to: (a) reroute most existing lines; (b) present a uniform compatibility of fast service and comfort to area patrons; and (c) comply with changes in local area planning which have been precipitated by the Rapid Transit impact.

This item will evolve a final report with recommendations for a programmed modernization compatible with the new rapid transit system. Recommendations will include a program for financing capital improvements and a program of adequate maintenance. The major part of the work involved in this item will be executed by outside engineering and consulting agencies.

WORK ITEM III

DEVELOPMENT OF PLANS FOR DETERMINING THE MOST EFFICIENT SYSTEMS FOR THE TRANSFERRING OF PASSENGERS AND FOR HANDLING FARES.

Developing plans for efficient transferring of passengers includes a study of physical transfer facilities and, more important, since we are considering three independent operating agencies, methods for handling the actual transfer transaction. It is estimated that transfer passengers may constitute about one-half of the total rapid transit riding. Therefore, the application of a simple, fraud-proof, easily understood transfer transaction is vital. A new self-service fare collection system designed for the rapid transit must be melded smoothly with the two existing pay-as-you-enter systems.

These plans will be developed from the following scope of work:

A. Physical facilities:
   1. Off-street transit loops and loading areas
   2. Waiting areas

Passengers desiring to travel in the future to points within the East Bay and San Francisco conceivably might travel on more than one of the three operating systems (BARTD, ACCTD, and MUNI) in order to reach their destinations and consequently will be involved in one or more physical transfers between these systems.

The objective of this work item, therefore, is directed toward such type of passengers; how best to physically accommodate these passengers, with efficiency and in comfort, from their respective points of origin to their ultimate destinations within the aforementioned area.

Important aspects to be considered are:

1. Development of criteria for off-street transit loops, both in congested downtown areas as well as in outlying residential areas, which will take into account the need to accommodate passengers arriving (or departing) by such modes of transportation as private automobile, taxicab, and ACCTD or MUNI vehicles, or other.
   Such criteria would take into account projected passenger volumes; directions of travel; location of major streets or thoroughfares; adjacent land uses.
2. Determine design and layout of loading areas and waiting areas which will take into account the efficient handling of peak-hour volumes; passenger comforts, including walking distances, heat, light, noise, ventilation, accessibility, etc.
3. Develop methods of informing and educating passengers on utilization of transfer facilities.

B. Development of methods for determining the most desirable transfer facilities between stations and home-business-recreation areas, including those outside existing service areas.

C. Development of techniques for determining desirable methods of handling single and combination fares:
   1. Simple, fraud-proof, and easily understood system emphasized.
   2. Transfers, receipts, mechanical devices, etc., required.
   3. Auditing procedures for combination fares.

The coordination of services by these three agencies brings into play an extremely complex problem affecting both the passengers as well as the financial structure of these agencies.

Briefly stated, we are concerned with development of techniques for handling not only the passenger, but for the collection and handling of his fare. The problem is further accentuated by the fact that there are three different fare structures (one for each system), a multiplicity of fare zones, different mechanical devices for receiving and registering fares, different paper transfer arrangements, and so on.

From this demonstration we expect to develop a technique which will eliminate many of the complexities for the rider as well as the carrier, and which will develop at the same time an adequate auditing procedure for combination fares.

Work contemplated under this item is intended to complement and recognize the fare collection project, involving mechanical processes, being undertaken by BARTD.

WORK ITEM IV

DEVELOPMENT OF COST AND REVENUE ANALYSES TO DETERMINE THE ECONOMIC RESULTS OF COORDINATING SERVICES.

A. Considering changes in costs of servicing single agency passengers and passengers who become combination riders.

B. Methods of determining an equitable division of revenue and allocation of costs with particular consideration given to impact of BARTD.

The most modern techniques will be utilized in analyzing revenues and costs of operation of the existing carriers, taking into consideration any additional cost of handling both single and combination fares—after which a determination shall be made of the impact of BARTD upon existing carriers, together with the establishing of a formula which would provide for an equitable distribution of revenues and costs between the parties herein.

Since the utilization of a "joint fare" involving two or more of the agencies may affect both revenue and operating cost of each system, there must be a competent appraisal of the principal factors contributing to these changes in order to develop the basis for an equitable distribution of joint fares, revenue and cost.

In making this determination, consideration shall be given to the progressive manner in which BARTD operations will be superimposed upon existing carriers.

WORK ITEM V

DETERMINING THE REQUIRED FARE STRUCTURE TO COVER COSTS OF SINGLE AND COMBINATION RIDES, INCLUDING ANY ALTERNATES.

A. Effects on revenue/mile and/or revenue/hour resulting from proposed changes in route and frequency of service.

B. Basic fare and zone structure.

After Item IV has been completed, then analyses shall be made to determine the effects per mile or per hour on existing carriers, to the end of determining the necessary changes in fares to provide for required revenues to cover the cost of both single and combination rides. In addition to the above, a detailed analysis of the present fare structures and method of handling fares, including zone limits, transfers, etc., shall be made together with recommendations for changes necessary to be compatible with the coordination operation and to provide for a sound basic fare structure—the administration of which would be convenient for passengers and should provide for sufficient revenues for the operator.

To accomplish this purpose would require the services of an expert in fare structure and fare analysis field.

WORK ITEM VI

DETERMINATION OF METHODS FOR EVALUATION OF EFFECTS OF COORDINATION PROGRAM ON EXISTING TRANSIT SYSTEM.

A. Effect on such items as passenger volumes, revenues, manpower, equipment requirements, shop and storage facilities, and operating costs on individualized agencies and collective efforts.

On completion of work through Item V, the basic data would be available to finalize the ultimate effects of the impact in coordination services with BARTD.

In making these determinations, the best techniques of the industry should be recognized in order to effect the best utilization of manpower, equipment and facilities, and while a considerable amount of the answers could be determined by staff of respective agencies, outside qualified engineering and operating advice will be most desirable.

WORK ITEM VII

METHODS AND TECHNIQUES FOR PROMOTING USE OF COORDINATED TRANSIT SYSTEMS.

Upon completion of the above work items, together with the necessary reports, then the best imaginative procedures will be utilized in educating the public as to the advantages of the new and coordinated operations. The end result will be a high level of acceptability to the combined operation, resulting in an overall improved transportation system serving the entire area.

Furthermore, complete reports will be made and distributed freely so as to serve as a guide to other areas in solving comparable problems and that the general public may be enlightened as to the problems and to the techniques used in finding a solution to such problems.

Appendix B—PROJECT BUDGET

The original budget estimates were prepared by representatives of the three operating agencies concurrently with development of the Work Program. The total effort was subdivided into two Federal agreements in order to accommodate local administrative restrictions; it was necessary therefore to divide budget amounts on each Work Item between them, as shown in the table below.

Reapportionment of cost estimates among Work Items was made as the project progressed. However, the overall estimates of the agencies' contributions and the total cost of the project were not changed. Part of the budgetary adjustment was due to the fact that the date of completion was extended beyond the original time estimate.

	ORIGINAL			ADJUSTED		
WORK ITEM	Cal-MTD-5 ACCTD/BARTD	Cal-MTD-6 MUNI/BARTD	COMBINED	Cal-MTD-5 ACCTD/BARTD	Cal-MTD-6 MUNI/BARTD	COMBINED
I	$100,000	$100,000	$200,000	$121,293	$121,293	$242,586
II	20,000	200,000	220,000	20,000	209,439	229,439
III	26,500	26,500	53,000	29,646	29,646	59,292
IV	16,000	16,000	32,000	20,278	20,405	40,683
V	28,000	16,000	44,000	30,595	20,405	51,000
VI	46,500	46,500	93,000	32,615	33,385	66,000
VII	4,000	4,000	8,000	4,735	5,265	10,000
Subtotal	$241,000	$409,000	$650,000	$259,162	$439,838	$699,000
Administration	27,800	47,200	75,000	34,638	58,862	93,500
Contingencies	25,000	42,500	67,500	—	—	—
Subtotal	$ 52,800	$ 89,700	$142,500	$ 34,638	$ 58,862	$ 93,500
TOTAL	$293,800	$498,700	$792,500	$293,800	$498,700	$792,500

The amounts shown for each of the seven Work Items include the costs of the primary consultant, subcontractors, "in-house" work performed by the staff of the agencies and all other expenses incidental to the Work Program of the project. Similarly, the administrative portion includes all expenses relating to the administration of the project.

A significant factor which made it possible to keep within financial limitations of the project was that the primary consultant used computers extensively in lieu of manual labor, resulting in considerable savings of time and labor. This also provided a large store of information which is available to the participating agencies for future use in the planning and evaluation of their future operations.

Appendix C—TECHNICAL MEMORANDA

Twenty-four technical memoranda were prepared during the course of the project on various items in the Work Program to reflect progress of the project and provide preliminary indications to the operating agencies. These technical memoranda were distributed to operating personnel and other agencies identified closely with local transit in the Bay Area. They formed the basis of discussion among agencies and the contractors on the project and provided feedback in developing succeeding phases of study.

The numbered series of technical memoranda under each work item, together with title, author and date thereof, is as follows:

Tech. Memo No.	Title	Author	Date	
	Work Item I: Traffic & Routes			
11	Characteristics of Bay Area Transit Riders in 1965	Simpson & Curtin	Sept.	'65
12	Highway System Characteristics	Simpson & Curtin	Feb.	'66
13	Estimating Future Transit Use	Simpson & Curtin	Feb.	'66
14	Population and Employment Projections, 1975	Simpson & Curtin	May	'66
15	Evaluation of Proposed Transit System for AC Transit District	Simpson & Curtin	Nov.	'66
16	Evaluation of Proposed Transit for San Francisco	Simpson & Curtin	Nov.	'66
17	Evaluation of Feeder Bus Operations in New Service Areas	Simpson & Curtin	Dec.	'66
	Work Item II: Muni Modernization			
21 A-B	Inventory and Evaluation of the San Francisco Municipal Railway Rolling Stock, Way and Structures	Kaiser Engineers	Dec.	'65
21 C	Inventory and Evaluation of the San Francisco Municipal Railway Shops and Garages	Kaiser Engineers	Feb.	'66
21 D	Power, San Francisco Municipal Railway	FMC Corp.	Mar.	'66
22 A-B-C	Plan Preparation for the San Francisco Municipal Railway, Rolling Stock, Way and Structures, Shops and Garages	Kaiser Engineers	Apr.	'66
23	Future Garage Facilities for AC Transit System	Simpson & Curtin	May	'67
	Work Item III: Fare Collection			
31	Fare Collection, Background Information	FMC Corp.	Nov.	'65
32	Alternative Fare Collection Systems	FMC Corp.	Feb.	'66
33	The Preferred Fare Collection System	FMC Corp.	July	'66
34	Joint Fare Collection Under a Coordinated Bay Area Transit System	Simpson & Curtin	Jan.	'67
	Work Item IV: Revenue & Costs			
41	Revenue and Cost Analysis	Simpson & Curtin	Jan.	'66
42	Revenue and Cost Projection 1975 Operating Results of Bay Area Transit Systems	Simpson & Curtin	Dec.	'66

	Work Item V: Fare Structures			
51	Analysis of Present Fare Structures	Simpson & Curtin	Feb.	'66
52	Alternate Fare Proposals	Simpson & Curtin	June	'66
53	Fare Plans, Passenger and Revenue Projections	Simpson & Curtin	Nov.	'66
54	Alameda-Contra Costa Transit District Fare Alternatives for the Existing System	Simpson & Curtin	Jan.	'67
	Work Item VI: System Coordination			
61	Effect of a Coordinated Bay Area Transit System on Existing Transit Systems	Simpson & Curtin	Jan.	'67
	Work Item VII: Promotion			
71	Promotion of Transit Service in the Bay Area	Simpson & Curtin	Jan.	'67

The supply of these technical memoranda is exhausted. Copies may be inspected at the general offices of BARTD and Muni in San Francisco, of AC Transit District in Oakland, as well as the Transportation Section of Department of Housing and Urban Development in Washington, D.C. and the offices of Simpson & Curtin in Philadelphia.

In addition, the technical memoranda have been reproduced in microfiche by Clearing House for Federal Scientific and Technical Information, U.S. Department of Commerce, Springfield, Virginia 22151. Copies may be obtained at nominal cost either in microfiche form or hard copy by contacting this agency directly.

Appendix D—PROPOSED CHANGES IN MUNI SERVICES PRESENTED TO PUBLIC UTILITIES COMMISSION

Before and during the course of NCTDP, the San Francisco Public Utility Commission received numerous requests for route changes or service extensions from various individuals and organizations. These were submitted to the consultants for study and for their expression of feasibility, consistent with the objective of overall coordination of the Bay Area transit network.

The requests and recommended disposition are as follows:

1. **Reroute and relocate eastern terminal of Route 51 to facilitate transfers at Third and Palou Streets:** Recommended.
2. **Reroute line 17X via the Southern Freeway:** Recommended as an intermediate step until this route is eliminated under the proposed plan.
3. **Extend Route 59 to vicinity of Beach Street:** Recommended as part of proposed plan to provide more direct service to Fisherman's Wharf.
4. **Extend Route 29 on Mansell Street to University Street:** This service provided for by proposed new Route 82.
5. **Additional service from Potrero Hill to the CBD:** Not recommended—proposed plan provides for extension of Route 53 to BARTD 16th Street Station.
6. **Improved service in Bernal-Peralta Heights:** Service to this area will be improved by proposed connection of Route 23 to BARTD 24th Street Station.
7. **Service from Forest Knolls to Irving Street shopping area:** Not recommended—traffic analysis shows insufficient justification for the addition of this service.
8. **Service to Diamond Heights from the east:** Not recommended—traffic studies show insufficient patronage to justify this service.
9. **Service from vicinity of Felton and Madison Streets to Mission Street:** Recommended as part of proposed new Route 81.
10. **Service to Mission Street from Avalon Avenue and Moscow Street:** Recommended as part of proposed new Route 81.
11. **Extension of Route 15 to Fisherman's Wharf:** Recommended.
12. **Extension of Downtown Shoppers' Shuttle to Folsom Street:** Analysis shows insufficient justification for this addition to existing service.
13. **Extension of Route 6 on 14th Avenue:** Not recommended—difficult terrain restricts transit service; area is now served by Route 66.
14. **Service on California Street between Presidio and Van Ness Avenues:** Not recommended—adequate service now provided by Route 55.
15. **Change Route 81 to operate via Williams Avenue:** Recommended.
16. **Service to Market Street from Harrison and Spear Street:** Not recommended—adequate service now provided by Route 32.
17. **Change Route 30X to operate via Powell and Pacific Streets:** Not recommended—study did not show any improvement over present routing.
18. **Service to the Produce Market:** Provided by recommended rerouting of Route 10.

19. **Service to the Hall of Justice:** Improved service provided under the proposed plan by Route 15X and extension of Route 25 north of Market Street.
20. **Extend Route 55 to 6th Avenue and Geary Boulevard:** This service is provided under the proposed plan by Route 5.
21. **Service to Southern Hills in San Mateo County:** Not recommended.
22. **Extend Route 45 in the Presidio:** Not recommended—traffic analysis shows insufficient justification for this extension.
23. **Service to Stonestown area on Sundays:** Not recommended—traffic analysis shows insufficient justification for this service.
24. **Operate Route 27 via Folsom Street between 1st and 2nd Streets:** Under the proposed plan, Route 27 would be eliminated. Service on Folsom Street would be provided by new Route 41X.
25. **Operate Route 38 via O'Farrell and Post Streets:** Not recommended—under the proposed plan, this service would be provided by Richmond Rapid.
26. **Turnback all east-west Routes at Market Street:** Not recommended.
27. **Reroute east-west service to Civic Center:** Not recommended—analysis shows insufficient justification for this change over service now provided.
28. **Weekday service to Legion of Honor:** Not recommended—traffic analysis shows insufficient justification for this service.
29. **Change Route 11 to Douglas Street between 24th and 25th Streets:** Not recommended—under the proposed plan, this service would be provided by Routes 24 and 35.
30. **Express service from the Sunset District to the financial district:** Recommended—this service would be provided by Sunset Rapid.
31. **Change Route 15 to operate via Brookdale and Blythdale Avenues:** Not recommended—route analysis shows insufficient justification for this change.
32. **Extend Route 80 south of Market Street:** Recommended—in proposed plan, extension of Route 25 north of Market Street would provide this service.
33. **Extend Route 16X to New Montgomery and Howard Streets:** This service will be provided under the proposed plan by Sunset Rapid.
34. **Change Routes 2 and 45 to operate one-way on Bush and Pine Streets:** Not recommended on the basis of travel patterns determined by traffic analysis.
35. **Terminate alternate Route 38 vehicles at Ferry Terminal:** Not recommended—existing routes on Market Street from 1st Street to Ferry Terminal adequately provide this service.
36. **Extend Route 37 from Burnett Avenue:** Recommended—extension via Crestline and Parkridge Drives.
37. **Change Route 40 via Hawthorne Street:** Not recommended—study shows no improvement over existing route because of difficult turns from New Montgomery Street to Hawthorne Street.
38. **Change Route 36 to operate through Forest Knolls and Route 34 to operate through Midtown Terrace:** Not recommended—these areas are adequately served by present routing; extensions are not justified by traffic demand.
39. **Change Route 17 to operate via Stonestown:** Not recommended—analysis of travel on this route shows insufficient justification for this extension.
40. **Service between Union Square and Golden Gateway:** Not recommended—travel pattern analysis shows insufficient justification for this service in addition to existing service.
41. **Service to Lake Merced Area:** Not recommended—analysis of travel demand shows insufficient justification for this service.
42. **Service between Hunters Point and San Francisco General Hospital:** Recommended—this service will be provided by the proposed change in Route 24.
43. **Service on Laguna Street between the Marina and Market Street:** Not recommended—analysis of travel patterns shows insufficient justification for this service.
44. **Service from Diamond Heights to the west:** Not recommended—analysis of travel demands from this area shows insufficient justification for this additional service.
45. **Service to cemeteries in San Mateo County:** Not recommended.
46. **Change Route 36 to eliminate turn at Staples Avenue and Foerster Street:** Not recommended—extend red zone on Foerster Street to 40 feet to facilitate turns.
47. **Service from Twin Peaks:** Not recommended—travel pattern analysis shows insufficient justification for additional service from this area.
48. **Express service between Federal Building and Transbay Terminal:** This service will be provided by the BARTD Market Street line.
49. **Change western terminal loop of Route 51:** Not recommended—under proposed plan, Route 51 would be through-routed to west of Mission Avenue.
50. **East-west service on Broadway:** Not recommended—analysis of travel patterns shows insufficient justification for this additional service.
51. **Extension of night and weekend Route 41 service to Transbay Terminal:** Not recommended—existing terminal is within one block of Transbay Terminal and additional mileage is not justified.

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